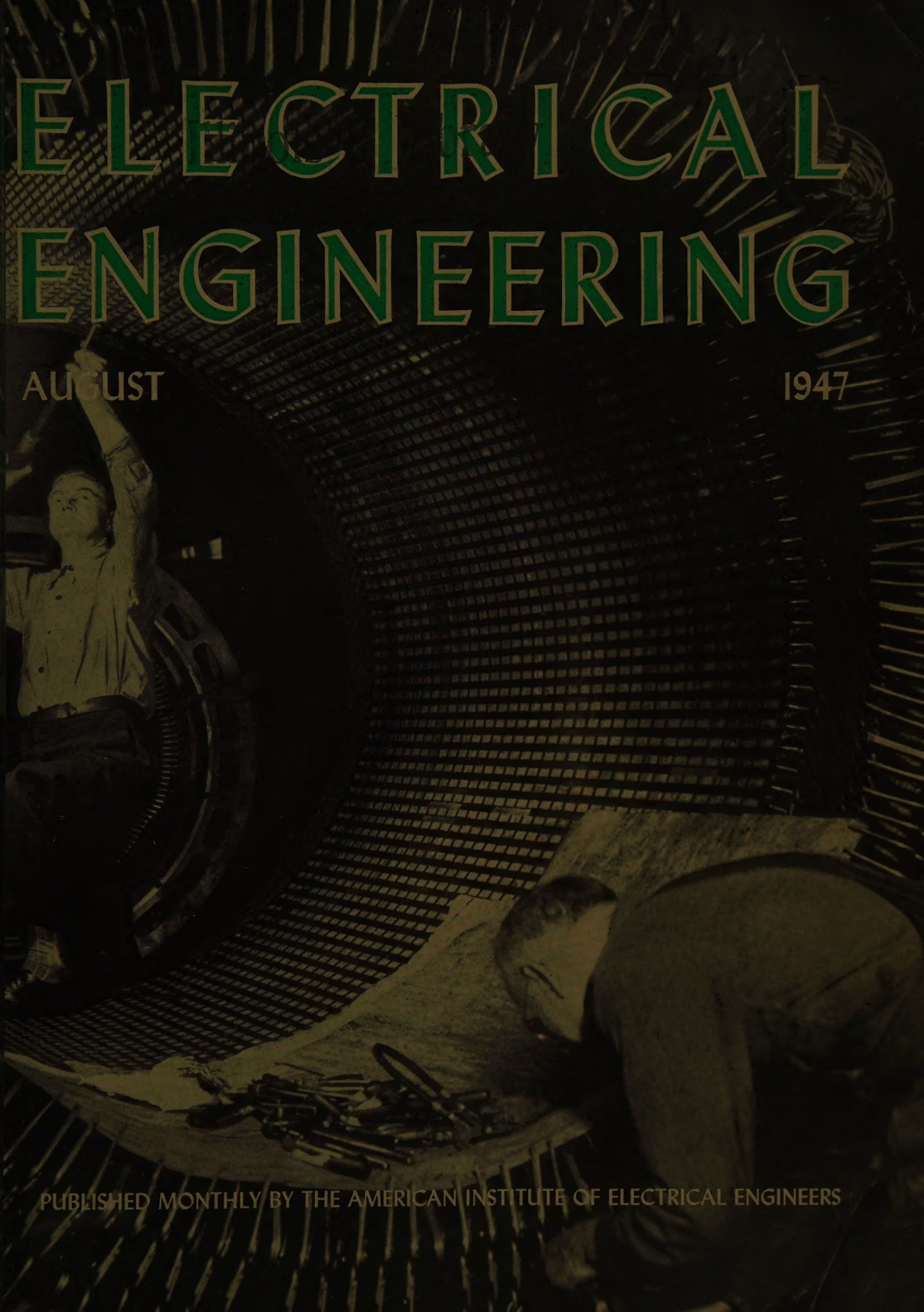
ELECTRICAL ENGINEERING

AUGUST 1947



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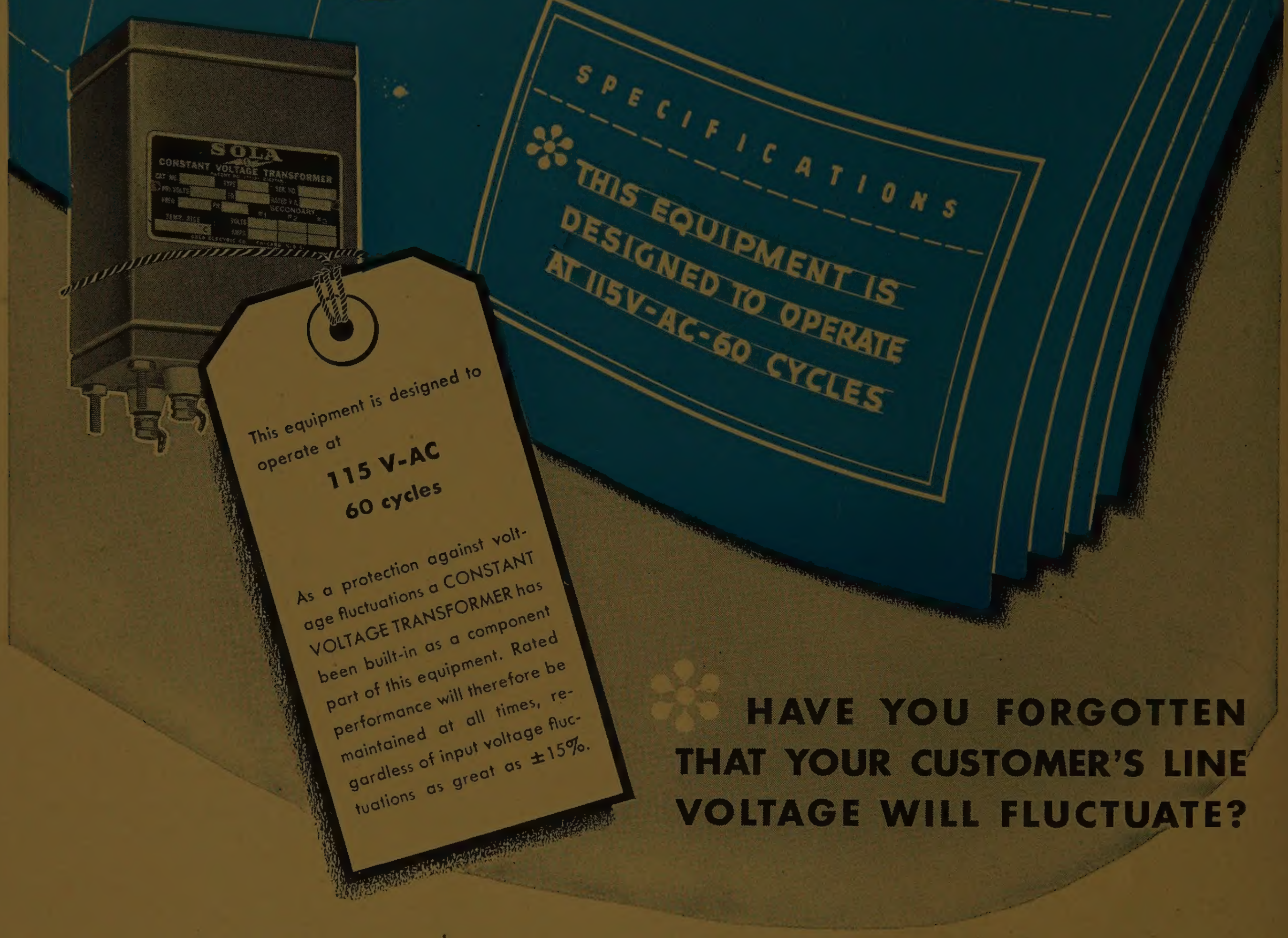
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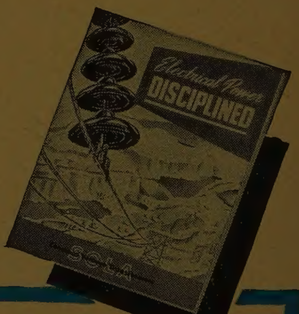

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ELECTRICAL ENGINEERING

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AUGUST
1947

The Cover Giant motor being built at the Schenectady, N. Y., works of the General Electric Company.

General Electric photo

Lamme Medalist for 1946

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Where there is Horsepower...

There is Wire

Belden

WIREMAKER FOR INDUSTRY

There are ten thousand hurdles that horsepower has mastered. Harnessed horsepower counts shipping cases or molecules; it integrates complicated mathematical problems; it assists in healing the sick; it even stoops to pick up and magnify the song of the goldfish.

Only during the last half century has man mastered horsepower and come of age electrically. Such strides have only been made possible through the collaboration of the wiremakers in making available the wide variety of products—from fine filaments to heavy cables. Belden Manufacturing Company has grown through this same period—and has been foremost in pioneering specialized wires that harness horsepower.

John Bayfield MacNeill

Lamme Medalist for 1946

PRESENTATION of the Lamme Medal for 1946 to John Bayfield MacNeill (F '42) manager of the switchgear and control division of the Westinghouse Electric Corporation, was made June 11, 1947, during the AIEE summer general meeting at Montreal, Quebec, Canada. Mr. MacNeill was awarded the medal "for his foresight, leadership, and creative contribution in the development of switching equipment." The award has been made each year since 1928 to an engineer "who has shown meritorious achievement in the development of electrical apparatus or machinery."

The Lamme Medal

A. C. MONTEITH
FELLOW AIEE

THE LAMME MEDAL was established through a bequest by the late Benjamin G. Lamme, who was chief engineer of the Westinghouse Corporation, to provide for an award by the Institute of a gold medal annually to a member of the AIEE who has shown "meritorious achievement in the development of electrical apparatus or machinery." The first award was made in 1928, and an award has been made annually since.

Mr. Lamme was not only an outstanding engineer, but was a real teacher and inspiration to anyone who had the good fortune to come in contact with him. I feel certain that his idea in establishing this medal was to require the profession to seek out engineers with meritorious achievement so that, over the years, they would be suitably recognized. In so doing, the honor not only would be an additional inspiration to the recipients, but would so single them out that they too, would be an inspiration to others.

BENJAMIN GARVER LAMME
1864
1924
THE ENGINEER VIEWS HOPEFULLY THE HITHERTO UNATTAINABLE
THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS AWARDS THE LAMME MEDAL FOR MERITORIOUS ACHIEVEMENT IN THE DEVELOPMENT OF ELECTRICAL MACHINERY TO

The Lamme Medal

In my brief contact with Mr. Lamme (I attended one of the last engineering classes conducted under his guidance) I found him to be a real inspiration and a thorough and painstaking teacher. He counseled young men and helped them orient themselves in the industry. He closely followed the assignments in engineering school where Westinghouse students were required to work on their own to secure the answers to a number of fundamental questions. A recitation was held periodically to see what progress was being made. Mr. Lamme attended practically all of these recitations. He was a rigorous critic, but I never knew of anyone who had any feeling other than that of being helped because of the manner in which he conducted his criticism.

I remember one instance well when I answered a question on rotary converters. I had proved, to my satisfaction, that a certain design would not work. Mr. Lamme let me complete my exposition, and then in his quiet voice said, "We build them, and they work."

He then, in detail, reviewed my exposition up to a point, corrected the error in my reasoning, and questioned me on the conclusion.

This incident is just one illustration of Benjamin Lamme's methods. His understanding of fundamentals was so thorough that even though he corrected you he covered the subject in such simple terms and in such an understanding manner that at no time was it taken as criticism but rather as a real desire of this man to give as much of his knowledge to young men as time would permit.

He was a man with broad and varied interests. Although many have thought of him primarily as a rotating machine designer because of his excellent work on rotary converters, induction machines, and so forth, he was versed very broadly in all types of electric apparatus. This may be the reason why he specifically mentioned electric apparatus as well as machinery in setting up the requirements for the Lamme Medal.

The medal serves, therefore, not only to recognize one oustanding engineer each year, but it requires the electrical profession to sit down each year and count its blessings one by one. In this way we are made more conscious of the achievements of one man, and recogni-

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Essentially full substance of the addresses delivered during the Lamme Medal presentation ceremony at the AIEE summer general meeting, Montreal, Quebec, Canada, June 9–13, 1947.

A. C Monteith is manager of headquarters engineering department and director of education, Westinghouse Electric Corporation, East Pittsburgh, Pa.

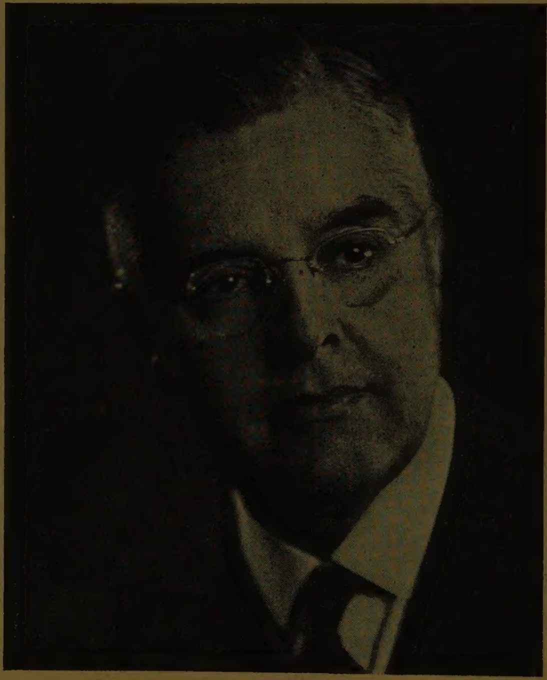
tion of him serves as a further inspiration to the rising generation in the profession. I know this was Mr. Lamme's aim and hope when he established the Benjamin Garver Lamme Medal.

The Medalist's Career

S. M. DEAN
FELLOW AIEE

THE GROWTH of almost every great industry rests upon the progressive development of one or more key auxiliaries, devices, or processes vital to its functioning. As an example, the railroads have the air brake and the block signal without which modern high-speed railway trains could not be operated.

In that respect electricity supply is no exception. As examples—it has the lightning arrester, the circuit breaker, and the relay, without which it could not operate overhead distribution or transmission lines, upon the relatively low cost of which the present-day price of electricity is based.



John B. MacNeill

The circuit breaker comprises a very substantial part of the cost of an electric system. It adds nothing to the load-carrying capacity or the efficiency of an electric circuit. Its only function is to safeguard service and to do so it, itself, must be very dependable if it is not to cause more trouble than it avoids. Also, because it is a "necessary evil," its cost must be kept as low as is consistent with good service. These requirements are conflicting, and a great deal of good economic and engineering judgment are necessary both in the design and manufacture of circuit breakers and in their application.

It was in this difficult field of circuit breakers and their associated devices that the 1946 Lamme Medalist some 30 years ago cast his lot. In view of the then precarious state of that field, he was a courageous man, as has been amply proved since.

THE MAN

It has been said that any successful enterprise or development is merely the elongated shadow of one or more courageous and able men. In the field of switchgear there may have been several such men, but the shadow of today's Lamme Medalist long will be recognized as one of the most prominent.

John Bayfield MacNeill was born at Summerside, Prince Edward Island, Canada, on June 8, 1888. In his early days his parents moved to Boston, Mass., where he received his grammar and high school education, and where he was graduated from the Mechanic Arts High School in 1906. Following his graduation, he entered the employ of the Holtzer-Cabot Electric Company as a draftsman where he earned his living while attending the night classes of the Lowell Institute for Industrial Foremen at the Massachusetts Institute of Technology from which he was graduated in 1908. Now, any one who has worked by day and at the same time has carried on night school work successfully knows something of the degree of persistence that is required and of the sheer ability to "take it." That trait of character has been significant throughout John MacNeill's career.

Shortly after the completion of his night courses he deserted Boston for the Pittsburgh area, and in 1909 joined the Westinghouse Corporation as a draft man in the department of industrial engineering where he spent a year or more.

In 1910 John MacNeill raised his sights, as he has done so many times since, and left Westinghouse employ to study and to be graduated from the Massachusetts Institute of Technology with a bachelor of science degree in electrical engineering.

Thus equipped, he re-entered the Westinghouse organization in 1913, this time as a design engineer in the switchboard department, and there began his long series of contributions to circuit breaker development.

By 1917 he was made section engineer in the supply department which then was responsible for switchgear. By 1926 he had risen to manager of circuit breaker engineering. In 1931 he became general manager of distribution engineering covering the whole range of protective equipment as manufactured by the Westinghouse Corporation. By 1935 he had become manager of engineering for the switchgear division, and from 1944 to date he has been manager of the switchgear division which includes the administration of the sales and manufacturing

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S. M. Dean is chief engineer of the system, The Detroit Edison Company, Detroit, Mich.

as well as of engineering, not only for the switchgear division itself, but also for the porcelain plant at Derry and the newly acquired plant at Beaver, Pa., for the manufacture of standardized control equipment.

Altogether, John MacNeill's career has been one of steady and progressive accomplishment. Each step has been based on careful investigation and the exercise of mature judgment. He has gained the confidence of his customers and also of his own organization, both for his engineering and his administrative ability.

I have discussed only Mr. MacNeill's technical and business interests thus far. He has others as well. For a number of years he held the shot-put record for western Pennsylvania. He enjoys golf and has a low handicap. He is a member of the Masonic Order and is also active in the affairs of the Methodist Church. In addition, he has a scholarly turn. Altogether, he is a man of well-rounded interests.

HIS ACCOMPLISHMENTS

I shall review only a few of his accomplishments over the years, but those few will indicate the reasons for the high regard in which he is held among electrical engineers everywhere.

When Mr. MacNeill entered the switchboard department of the Westinghouse Corporation, the manufacture of circuit breakers was an art and was based largely on trial and error—a lot of trial and no small amount of error. Power concentrations were rising rapidly and it was becoming apparent that some means of proof-testing circuit breaker designs was vitally necessary. Some of the more venturesome power companies made short-circuit tests on their systems, but these, of necessity, were few in number and by no means sufficient to investigate thoroughly the many potential forms of development. Mr. MacNeill early was involved in these tests on users' systems and acquired, at first hand, knowledge of their problems. That knowledge, together with his sympathetic interest in the user's point of view, since has stood him and the electric power industry in very good stead. He was unwilling to believe that the power industry would stand still merely because of immediate switchgear limitations, and he repeatedly "raised his sights" and went to work with a will to produce what was needed.

He was one of those who early realized the need for high power testing laboratories if switchgear developments were to keep pace with the needs of electricity supply without costly duplication and segregation of equipment. He did much to bring power testing laboratories into being, with all that it meant in pointing the direction of advancement through the maze of ingenious possibilities then being put forward. Not only was he instrumental in initiating power testing laboratories, but he also urged that they be increased in size to keep pace with the growing needs. He has consistently been a proponent of proof-tested switchgear.

Mr. MacNeill has been responsible for a number of circuit breaker and related developments which have meant much to the producers and users of electric power.

Outstanding among these was the distribution type of circuit breaker of the 15,000-volt class having three poles in a single round tank and designed to be really oiltight. From the point of view of the user, this design was important because it did much to reduce the size and cost not only of the circuit breaker itself, but also of buildings to house it. Its success paved the way for the development of present-day standardized metal-clad switchgear with all that it means in reduced costs and simplicity of installation. The acceptance and approval of factory-assembled metal-clad switchgear was immediate and almost universal.

As cities grew in size it became necessary in the densely populated areas to put both primary and secondary lines underground, and as a result the a-c network developed as we know it today. The heart of the a-c network system, as commonly used, is the secondary network protector, the function of which is to disconnect from the network any faulty primary feeder or transformer without impairing the service. Mr. MacNeill early realized the power industry's great need for such a device and set to work to develop and provide a satisfactory one—which he did. The perfection of that device has made the modern a-c network economically practicable.

As power concentrations grew and switching equipment of the indoor types became intermingled more intimately with factory production equipment and more heavily concentrated in substations, there arose an increasing demand for oilless circuit breakers of the 15-kv and lower classes. Accordingly, the Westinghouse Corporation, under the direction of Doctor Joseph Slepian, undertook a program of fundamental research from which developed the cold cathode method of arc interruption, later known as the deionization principle. It fell to Mr. MacNeill's lot to adapt the principle to commercial lines of circuit breakers which are now well known as the type *U* deion circuit breakers. While basic design principles are a first necessity, it is a far cry from those fundamentals to a commercial line of circuit breakers, and both experience and mature judgment are necessary to come out with commercially feasible and competitive equipment.

The Westinghouse De-ion Grid developments followed, by which circuit breaker arc energy was reduced greatly and the interrupting capacity and speed of oil-filled circuit breakers tremendously increased. Again, it was a matter of reduction of a principle to commercial lines of circuit breakers with all that such a process implies by way of skill and judgment. Not only were the new deion interrupters incorporated into new designs, but what was perhaps more immediately important, they likewise were adapted to the modernization of existing circuit breakers with a very real saving to the power companies. Again, there was the appreciation of the necessity faced by the user to continue the value of his large investment in older circuit breakers.

The De-ion Grid development has been modified and extended to 287-kv service and also into the present Multiflow De-ion Grid interrupter.

Mr. MacNeill also did outstanding work in the development of lines of indoor heavy-duty oilless circuit breakers for power plant use. Those, and similar, developments have made possible the continued usefulness of earlier switchhouses at a very real saving to the power supply industry.

One of the most recent developments carried out under Mr. MacNeill's direction has been the design of magnetic blow-out high-voltage air circuit breakers. Also, he has developed experimental compressed air circuit breakers for outdoor high-voltage application, some of which have been installed for field trial.

Perhaps the most outstanding accomplishment of the medalist's career has been his co-ordination, from 1943 through 1945, of the Westinghouse Corporation's contributions toward the carrying out of the "Manhattan Project" to build atomic bombs. While much of the equipment supplied by Westinghouse was switchgear, a wide range of process equipment also was provided, and that equipment is said to have first produced fissionable material in usable quantities. Mr. MacNeill specifically was commended by the United States Army and further rewarded by being invited to witness the underwater bomb tests at Bikini Atoll in July 1946.

Altogether, the medalist's contributions have bridged the gap from the early days in which circuit breaker building was a very uncertain art to the present when it is a well-established engineering development based on a reasonably ample foundation of experience. As a result of the work of the medalist and a very few others, it is today practicable to extend our experience to cover any circuit breaker equipment which the electrical industry is likely to need for some time to come.

Throughout his career, John MacNeill has attained a comprehensive understanding of the circuit breaker needs of electricity in industry, and his sympathetic co-operation and his impartial attitude have enabled him and his associates to meet those needs.

Truly, his work is a "meritorious achievement in the development of electrical apparatus."

Lamme Medalists

1928	Allan Bertram Field	1937	Robert E. Doherty
1929	Rudolf E. Hellmund	1938	Marion A. Savage
1930	William J. Foster	1939	Norman W. Storer
1931	Guiseppe Faccioli	1940	Comfort A. Adams
1932	Edward Weston	1941	Forrest E. Ricketts
1933	Lewis B. Stillwell	1942	Joseph Slepian
1934	Henry E. Warren	1943	A. H. Kehoe
1935	Vannevar Bush	1944	S. H. Mortensen
1936	Frank Conrad	1945	David C. Prince
1946	John B. MacNeill		

The Switching of Large Power

JOHN B. MACNEILL
FELLOW AIEE

THE GREAT GROWTH of power generation in the United States and Canada has imposed problems of control through switching operations that at times have seemed impractical, and the general progress in this phase of the industry seems to justify comment. With few exceptions our large systems, in contrast to continental European practice, are grounded, and line-to-ground faults become short circuits in which flow many times the normal power and which therefore must be removed instantly. As most high voltage lines are overhead and lightning over large areas of the United States is severe, the duty on switches and circuit breakers from such faults is frequently heavy. Moreover, as most line flashovers will clear themselves in a few cycles if the power flow is removed, we have resorted to fast reclosure, both single and polyphase, as well as to fast interruption, to maintain stable operation at high loads with a minimum number of transmission circuits and with heavy bus concentrations of generators. This is obvious to power engineers and is the basis for the necessity that American switchgear perform under heavy and frequent duty with absolute reliability. The improvement in this respect in recent years has contributed much to the continuity of electrical service and to its low cost, and is a tribute to the men who have worked, often under difficult conditions, with the abstruse phenomena involved. It is more than chance that five of the last six Lamme Medal recipients have been identified with important switchgear developments. In accepting the present award I wish to stress the broad co-operative effort in the industry on the part of many capable engineers, both in utilities and manufacturing, who have furthered this advance.

CIRCUIT INTERRUPTERS

For many years circuit breaker development was strictly an art and operation suffered for lack of adequate development means. I can remember being present in a large station in the southern United States during a 1922 lightning storm, when most of the lines were out of service till the weather cleared because the switches, after having done their maximum duty, were not in condition to be closed without inspection and repair. This was not an isolated incident, and frequently the circuit interrupters of a system were a limitation on its ability to give adequate service.

At that time proof tests at high power were limited, in the absence of large manufacturers laboratories, to occasional courageous utility companies whose difficulties in operation prompted them to hazard deliberate short circuits on their systems to determine in advance what

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John B. MacNeill is manager, switchgear and control division, Westinghouse Electric Corporation, East Pittsburgh, Pa.

might be expected under fault conditions. They agreed with Hotspur—"Out of this nettle danger we pluck this flower safety." These men accepted considerable risk to their systems, for machines and transformers were not so strongly built as now, means of readily calculating short circuits were not available, and recording devices were not adequate, while the then prevalent slow operation of circuit breakers imposed unnecessary duty on connected equipment.

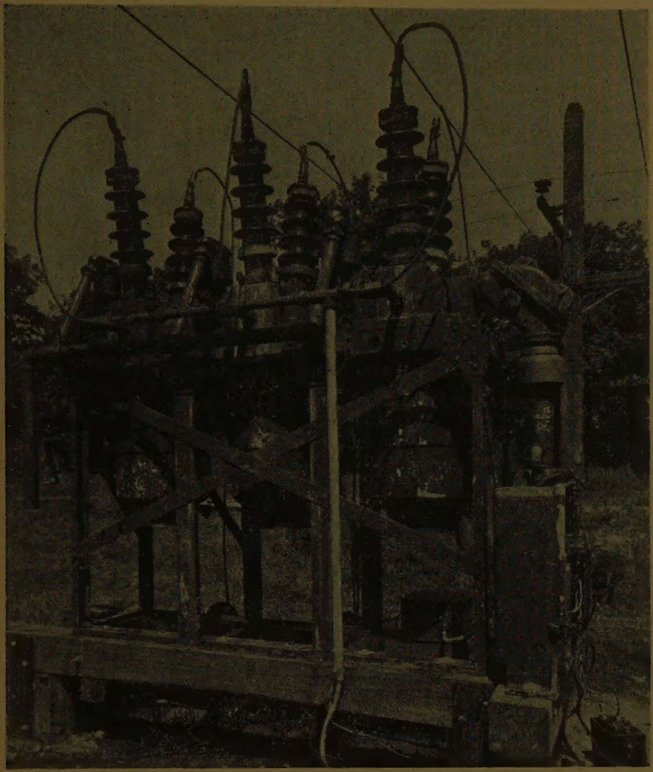


Figure 1. The interrupting performance of early circuit breakers could be determined only on operating systems and occasional field tests, generally under temporary and expedient conditions, and sometimes at hazard to the system providing the necessary design data

The destruction of an interrupter on short circuit can be a dangerous experience unless both personnel and apparatus are protected adequately against possible explosion and fire. My first experience with such a demonstration was in Detroit, Mich., in 1915 where about 500,000 kva was plunged, with disastrous results, into a circuit breaker—much to my youthful surprise, having been assured by those whose opinion was highly respected that it could not happen. The circuit breaker promptly was improved by older heads than mine and two weeks later did the job well. The whole affair for many years has been the basis of good-humored discussion on the brashness of young engineers and the advantages of joint effort between utilities and manufacturers. The tolerant and helpful approach of progressive utility executives who accepted the improvement of circuit interruption as a joint problem, did much to tide over a period when systematic study based on adequate facilities was not practical.

CO-OPERATIVE TESTS

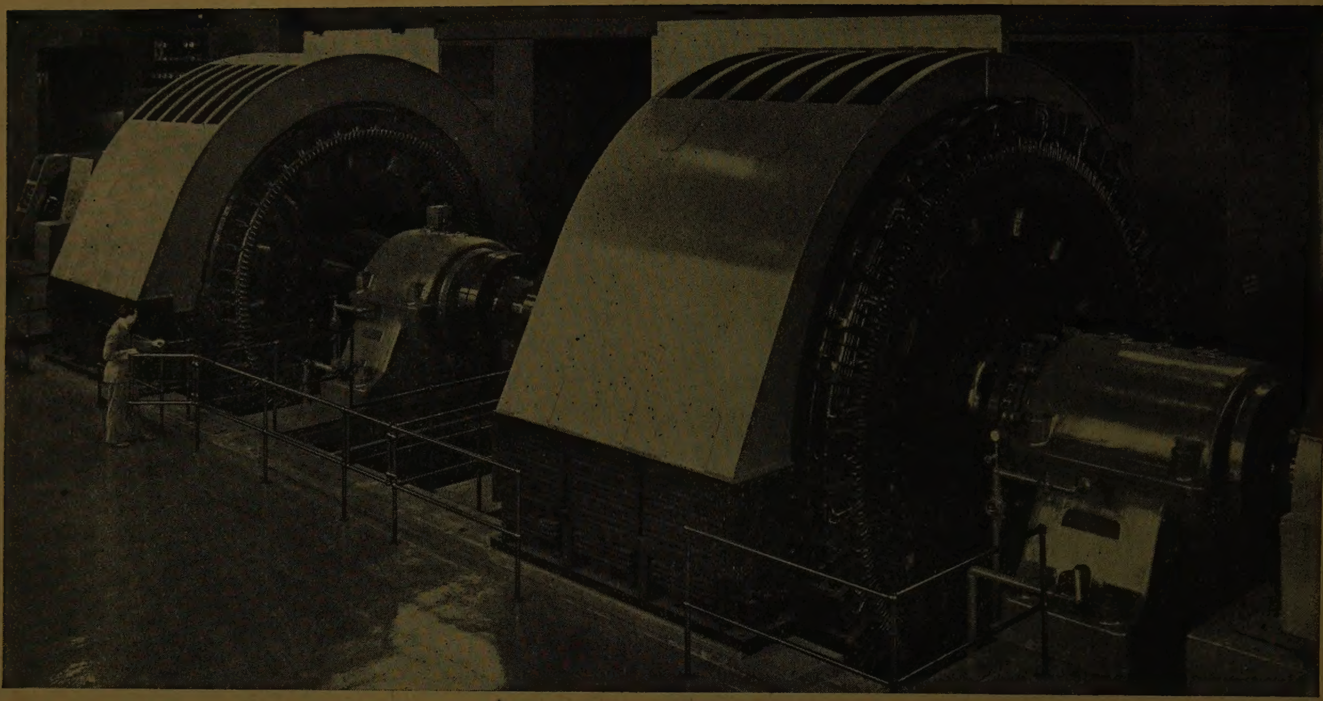
Co-operative test work has taken place on many large systems from New York to California and from Canada to Alabama, and on circuits from 2,300 volts to 230,000 volts, and most of the results are in the records of the AIEE. One such series of tests is mentioned not only because of what it indicated for future development, but also because the limited flexibility of test conditions resulted in certain wrong conclusions, which was typical of this type of test. The Baltimore tests of 1920 and 1921, to which I refer, were extensive and established definitely the grounded tank circuit breaker as adequate for heavy powerhouse service. They led directly to the design of the 1,500,000-kva Hell Gate Station equipment and pointed the way to a rational metal-clad construction for America which dismissed the necessity of compound or oil-filled gear.

It was noted during these tests, on the favorable side, that small units in some respects gave better operations than large ones, that is, a 16-inch tank handled as much power as a 28-inch tank and, because of magnetic blowout effects, the arc energy actually was less. This suggested that a substantial physical structure with all phases in a small area to increase magnetic effects, and built to withstand high internal pressures while equipped with scavenging means to remove gases from the structure, could be the basis of a simple metal-clad gear, easily accessible in all parts and relatively free from fire hazard. This has been largely the basis of our modern American metal-clad switchgear.

On the unfavorable side, this Baltimore work was done with 25 cycles, and erroneous conclusions were drawn regarding 60-cycle action. The voltage was 13 kv and extrapolation to 25 kv later was in error. The rates of recovery voltage were low and overlooked the effects of more difficult circuits. Even though 200 tests were made, the significant phenomena all occurred in a total of ten seconds so that analysis of results was restricted. It is axiomatic in switchgear work that the success or failure of a circuit interruption depends generally on what happens in 8/1,000 to 30/1,000 of a second. Longer periods can destroy the evidence rapidly.

HIGH POWER LABORATORIES

In more recent years, with the growth of power concentrations, the necessity for continuous attack on the switchgear problem has resulted in the building of high power laboratories which can be used each day of the year as necessary, and which are equipped with elaborate electrical and mechanical measuring devices. In one such laboratory nearly 200,000 short circuits have



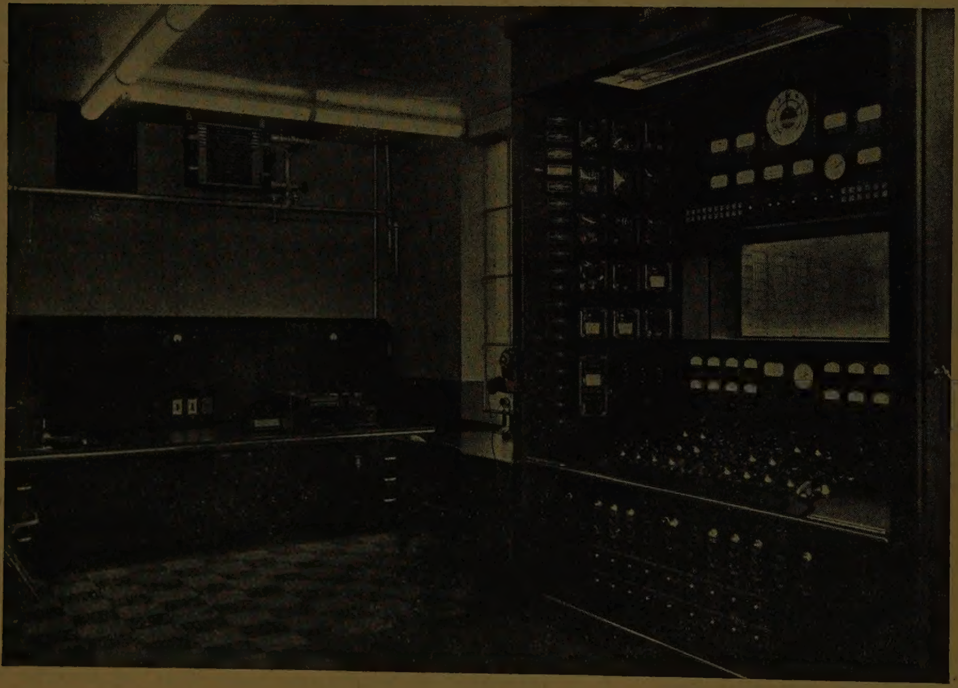


Figure 2. Circuit breaker performance under short-circuit conditions now can be determined with safety in manufacturers' laboratories which have generators available at all times, carefully and accurately controlled testing conditions, and permanently installed recording apparatus

been made in 15 years. By these means the art of switchgear design has been reinforced with a background of scientific data over wide ranges of power and circuit conditions. Improved interrupters with rapid arc deionization have been developed. Units in series with means for distributing the voltage reasonably between them have been made possible; undesirable electrostatic effects have been brought under control and the destructive possibility of hydrocarbon gas accumulations provided against.

Checks of these laboratory results against field conditions have shown reasonable agreement. Methods of laboratory testing involving special circuit connections and tests on portions of circuit breaker construction provide a reasonable basis for extrapolating such results to higher powers. For the future such extrapolation and field checking occasionally will be necessary, as there is a limit to laboratory size that can be provided economically while field concentrations continue to grow rapidly.

Through these facilities new ideas can be evaluated in a reasonable time, and users are supplied apparatus free from faults that might not show up for years in operation.

The available interrupting methods covering oil breakers, magnetic breakers, compressed air breakers, water breakers, so-called oil-poor breakers, and self-generating gas blast devices have been investigated and their advantages and proper fields of application explored commercially. At the present time in the United States, the trend is to magnetic types and compressed air for indoor service, while the oil circuit breaker, with some few exceptions, still commands the high voltage outdoor field.

Rating and performance now seem to match industry requirements. Three-cycle interruption is common on high voltage circuits with reclosure at 20 cycles or less. Interrupting capacities of $2^1/_2$ million kilovolt-amperes at generating voltages, $3^1/_2$ million kilovolt-amperes at 69 kv, 5 million kilovolt-amperes on 138 kv, are in service or being built. Values as high as 10 million or 12 million kilovolt-amperes on 230 kv with or without high speed reclosure are under discussion. These values would have seemed impossible two or three years ago, but system growth and efficient operation demand them, and fortunately the fundamental information to secure them is available. Recent successful field tests have been made at 230 kv up to 7 million kilovolt-amperes on a 3-phase basis, with interrupting times less than 3 cycles, and with high speed reclosure down to 15 cycles.

For the future the outdoor situation may change to use compressed air with its cleanliness and assured store of interrrupting fluid, or some other new means of circuit interruption. However, the improvement of the standard oil circuit breaker, its ability to take punishment with low maintenance, adequacy of insulation and protection against sleet, snow, water, and cold, together with the ease with which potential devices and current transformers can be applied, make it a formidable competitor for new ideas.

THE FUTURE

Interesting possibilities exist for future work. Should a noninflammable liquid be produced which would retain high dielectric strength after arcing, it would find a wide application. A gas-evolving solid material that would retain high creepage values after arcing also would command a wide use. More efficient use of compressed gas could simplify its generation and storage greatly. This field thus still holds many problems for the inventor and design engineer.

A helpful factor in the situation has been the simplification of the rating structure and the adoption of reasonable duty cycles by industry groups clearing through the Edison Electric Institute–Association of Edison Illuminating Companies–National Electrical Manufacturers Association joint committee of which George Sutherland is chairman. This committee for more than 15 years has stimulated developments where required and, at the same time, through simplified rating structures, has kept development work within bounds with resulting economic advantages to the industry generally.

The advanced control of electric power is only a reflection of the tremendous growth of the power itself. One cannot see the end of this growth and its beneficient effect on living conditions on the continent of North America. Several years of peak production, we are told, will be necessary to restore a reasonable balance of spare capacity above continuously rising loads.

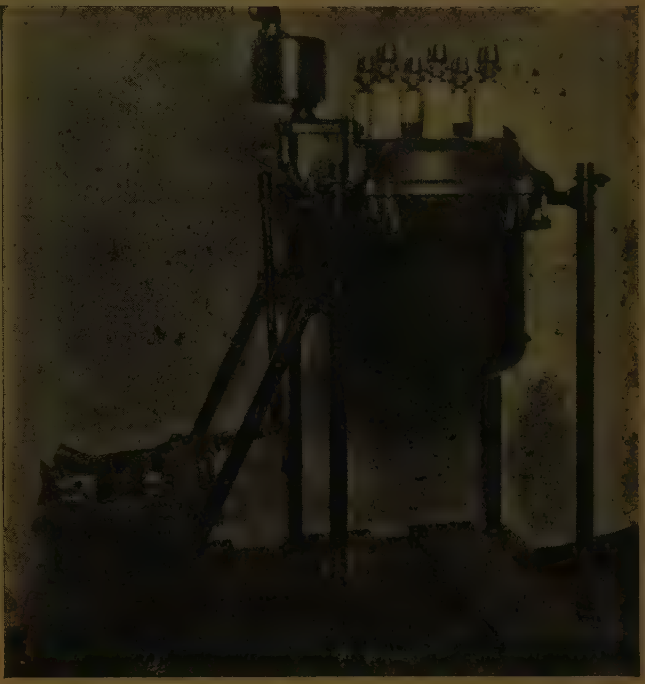


Figure 3. A small compact pressureproof structure with gas discharge controlled and with all phases closely spaced to increase magnetic effects opened new fields in circuit rupture and made practical modern nonoil-throwing switchgear

The ability to switch any desired power concentration is a definite economic advantage in the planning and operation of utility systems, resulting in simple bus construction, a minimum number of lines, frequent elimination of stabilizing equipment and current limiting devices, as well as better continuity of service. It can be said fairly that switchgear today not only meets the requirements of an expanded electrical industry, but is, for these reasons, a stimulating agent in that expansion. Because of these values of better switching to electric systems, the industry will feel free to demand more from its protective apparatus in the future. The present request to interrupt 10,000,000 kva or 12,000,000 kva at 230 kv in less than 3 cycles, and restore service in less than 20 cycles, may seem extreme now, but there is no assurance that this demand will not be exceeded in time. The continued co-operation of the users and makers of this equipment, which has proved to be successful in the past, is the best assurance that future requirements will be met.

The Defense of North America

A. G. L. McNAUGHTON
HONORARY MEMBER AIEE

THE FACT that we properly can use the inclusive term "defense of North America" is significant, for it symbolizes the very remarkable position which has come about in the development of friendly and close relations between the nations of the North American continent; the words themselves betoken the fact that today within North America there are no frontiers in the sense of separating boundaries between nations that have to be fortified and patrolled by armed forces on guard against some ever-present or potential risk of invasion or other military action. On the contrary, the boundaries between nations within the continent of North America are interlaced with open highways where great friendly peoples meet in free and peaceful intercourse for trade and commerce and to develop associations and enterprises which redound to their mutual advantage and benefit.

Collaboration in defense matters is not something which is new between the United States and Canada. During more than 100 years of peace we, the citizens of these two nations, have become accustomed to think of our common boundary, at least, not in terms of hostile actions.

We began this process in 1817 with the Rush-Bagot Agreement, a self-denying ordinance for mutual disarmament on the inland waters of the St. Lawrence Basin. This agreement, which is probably the oldest disarmament treaty in the world, is still in full force and effect. It is a living treaty which we have kept in close accord with changing times and newer circumstances.

In 1909, we took another important step in harmonizing our relations by establishing the International Joint Commission, which was set up to deal particularly with boundary water questions, but which gave us also an instrument for the peaceful adjustment of any other differences which might arise.

JOINT DEFENSE BOARD

The transition, from the negative conception of two states whose interests were separated by a frontier to a recognition of the need for positive association between the United States and Canada in defense, was expressed in Mr. Roosevelt's declaration in August 1938, when he said that "the people of the United States will not stand idly by if domination of Canadian soil is threatened" and Mr. King's reply that "we, too, have our obligations as a good friendly neighbor and one of them is to see that, at our own instance, our country is made as immune from attack or possible invasion as we reasonably can be expected to make it, and that, should the occasion ever arise, enemy forces should not be able to pursue their way, either by land, by sea, or air to the United States, across Canadian territory."

As the Prime Minister of Canada has said, these statements mark the first public recognition by both Canada and the United States of their reciprocity in defense based on acknowledged interest in each other's security. In August 1940, those statements were followed and made specific by a joint declaration by Mr. Roosevelt for the United States and by Mr. King for Canada, establishing the Permanent Joint Board on Defense.

The establishment of this joint board was the culmination of a long association in developing harmony between the peoples of the United States and Canada. As has been shown by the statement issued by the two governments last February, and more recently by the President of the United States speaking in Ottawa, the joint defense board is no temporary expedient dictated by a wartime anxiety of a possible threat from Europe or Asia. It is designed rather as a permanent and sensible arrangement to ensure continued existence in safety for

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Essentially full text of an address delivered at the AIEE summer general meeting, Montreal, Quebec, Canada, June 9–13, 1947.

General the Honorable **A. G. L. McNaughton,** formerly commander-in-chief of the Canadian Army in the European theater and later Minister of National Defense, is chairman of the Canadian section of the Canada-United States Permanent Joint Board on Defense, president of the Canadian Atomic Energy Control Board, and Canadian delegate to the United Nations Atomic Energy Commission.

the nations of North America as the world moves forward to a new order to be based, we hope, eventually on friendship and good will among all nations. I cannot overemphasize the fact that it does not represent any alliance formed as a threat to other peoples.

The Permanent Joint Board on Defense is organized in two national sections, each with a chairman. When the board meets formally the chairmen preside jointly, but with a single purpose—and I am sure my colleague, Mr. LaGuardia, will agree that this purpose is to ensure that a proper answer is given to every problem in the interest of the maintenance of North American security.

The procedure is by way of discussion and agreement—never by vote—and in all its history every conclusion of the board has been unanimous. The board is not executive which means that action is by way of recommendation and invitation, which is a most effective procedure when two nations have a united purpose which they fully understand and fully recognize.

Canada, like the United States, is fully aware that its security does not rest on the protection of the territory of North America alone. Canada realizes that this security requires continued association with other peoples of good will who also are devoted to the cause of peace.

CANADA'S DUAL POSITION

In addition to being a nation of the North American continent, Canada is also a member of the British Commonwealth of Nations, and she holds to that association with all the firm conviction which has marked the course of her history since early times. She holds to that association, not as any dependent colony of a central authority in London, but as a nation in her own right, exercising full sovereign powers, but happy to co-operate in all matters which make for peace and orderly progress in the commonwealth and in the world.

There are some who may see a difficulty in reconciling Canada's position as a nation on the continent of North America with her membership in the British Commonwealth, but I do not share this anxiety.

In the first place, I believe that, fundamentally, the real interests of the member nations of the British Commonwealth are very close to those of the United States. Both stand firmly for peace. In the second place, I think Canadians are a practical people, ready to deal with each question as it arises on its merits and on the basis of the facts. Canada sees no fundamental reason for conflict in interest, and every reason for co-operation between the British Commonwealth and the United States; and we can be quite sure that, with her deep concern for the welfare of each of these great associations of people with whom she is so intimately linked, Canada will devote herself on every occasion to promoting unanimity in view.

A very close and intimate association has been established between the engineers of Canada and the engineers of the United States. So that this association may be realized on a larger scale, so that all the people of the North American continent may come to recognize the vital interests which these two nations hold in common, General McNaughton, a Canadian, discusses some of their mutual problems and indicates something of the co-operation which now happily exists between the United States and Canada in their arrangements for the military protection and defense of North America.

In relation to military defense, it is most important to take note of the very remarkable progress which has taken place, particularly during the last two decades, in the application of science and engineering to war. Today, for those who are suitably prepared and equipped, distance largely has lost its former attenuating effect on the conduct of military operations, and we must realize not only that continents are now within aircraft range of one another, but also that, with new developments, already shrunken space continues to shrink still further.

We now have to contemplate the possibility of aircraft at supersonic speeds and of guided missiles of great range and to realize that, perhaps in the near future, these forms of bombardment may be followed up rapidly by considerable forces, air-borne, but capable of operating with great effectiveness on the ground. With the increased range of action and of speed in transit, continents today already have become the least geographical units on the basis of which questions of defense properly can be stated; consequently, effective arrangements for the defense of the territory of one nation have become matters of vital concern to all other nations of that continent.

It is evident that the people of both Canada and the United States are well aware of the changes which have come about in the basic considerations governing defense, and that they are anxious to be correctly informed regarding the nature, the scope, and the adequacy of the co-operative relations which exist between the two nations.

It was in recognition of this great public interest that on February 12, 1947, the joint statement to which I have referred was issued by the Prime Minister of Canada in Ottawa and by the Secretary of State in Washington, defining the measure of agreement which had been reached for co-operation in their respective defense policies. These arrangements are of great importance, both because of the positive measures of association, collaboration, and standardization which have been established between Canadian and American armed forces, and for the mutual and reciprocal availability of military, naval, and air facilities in each country which are announced. They are important also by reason of the statements of what is *not* intended, and in this respect they make clear to all the world that Canada intends to continue, as she always has done, to carry her full and proper responsibilities for the defense of her own territory and that all arrangements within her own territory will remain strictly under her own control. That is, as Mr. Truman has said, we "participate on the basis of equality and the sovereignty of each is carefully respected."

I think that the purpose to be served by this joint statement can be explained best by quoting some words used by Mr. St. Laurent, Canadian Secretary of State for External Affairs, in an address which he gave in New York last February. He then said:

> If, on the one hand, the joint statement indicates that we in Canada and the United States of America intend to maintain our independence of action, it says equally that we are prepared to enter on the basis of honourable partnership into plans for security which must, of necessity, involve the action of more than one state. As I have already said, we realize that no nation can live unto itself. We realize that the destiny of our country is bound up closely with that of the United States. We are, therefore, fully prepared to consider with you on the basis of our joint responsibilities and our joint interests whatever combined action either one of us may think desirable. This does not commit either one of us to agree to all the plans which the other one may put forward. It does, however, establish the fact that we shall discuss the question of defense freely with one another, and that where joint action commends itself to both of us, we shall be prepared to take it.

With these provisions for the free and intimate discussion of defense matters which are of mutual concern to Canada and to the United States, and for their orderly conduct through the medium of the Permanent Joint Board on Defense, no one in either of the two countries, or in any other country of the Western Hemisphere, need fear lest any of the precautions essential to the security of North America are being neglected.

The frontiers of North America are the Atlantic and Pacific Oceans and the North Polar Sea where Canada finds herself in closest geographical proximity to the great land masses of Europe and Asia. It is only across one or more of these expanses of water, or of ice, that any significant threat to the security of North America could come, and it would be of great interest to discuss the form and scale of such possible threats, their place in space, and in time, and the means which should be developed by which they could be met.

It is clearly not possible in the limited space available to marshal these factors in a closely reasoned account, but I will endeavor to make a few observations on some of the more important considerations as I view them. I would emphasize that what I have to say represents my personal opinions alone.

FACTORS TO BE CONSIDERED

The first question on which a conception must be formed is the source of a possible aggression against the frontiers of North America.

With regard to the potential military and industrial strengths of the countries of the world as they exist today, and as they reasonably may be projected some years into the future, it is clear that the only possible source of trouble which could threaten the safety of North America would be some combination of forces in Europe and Asia which had extended its dominance to the oceans to the west, to the east, and to the north.

As matters stand at present, such a consolidation of power does *not* exist, and, as prevention of catastrophe is many times more valuable than cure after the event, I say that the first provision for the protection of North America lies in developing international co-operation not only in the realm of security, but also for dealing with the vital political and economic questions whose solutions will serve to unite instead of dividing the world.

A medium through which these matters may be developed and brought to full effect is the United Nations, and it is through this organization that ways are opening up for peaceful progress which, we may hope, will transform opposing interest and suspicion into co-operative endeavor and mutual confidence and thus bring about, for all nations of the world, a relationship similar to that which we enjoy between Canada and the United States. We of the continent of North America who have been favored greatly by Providence have a special responsibility to help others less fortunate than we.

There is a wise old saying that "the strong man armed keepeth the peace" and this is as true in relation to nations, and regional groups of nations, as it is for individuals.

The application of this axiom to the present position of North America is that if we are strong in defense and conscious of our strength, we can go forward without anxiety to do those things which may make war impossible and to carry aid and comfort to those in need; in the opposite case, it may be expected that constructive action again will be paralyzed by timidity and fear or by indifference.

The factors which make for military strength have varied from country to country and from age to age. Sometimes it has been possession and skill in the use of a particular weapon; sometimes an advantage in movement or in communications; sometimes the stimulation of a great leader or a great cause; sometimes, though not often in history, it has been sheer numbers that have given advantage.

Today the military strength of North America rests on very special circumstances which exist here on a scale unmatched elsewhere in the world.

Our young people, on whom the future depends, are most highly educated; they have been familiar since their earliest years with mechanism in all its forms and uses; they have shown inventive abilities of the highest order and capabilities in research which are unexcelled; there is facility in organizing to handle the largest enterprise; there is discipline when the occasion requires, and courage in action and capacity to endure adversity have been proved beyond dispute.

Behind these priceless human and moral resources, which are notable characteristics of the people both of the United States and of Canada, North America possesses the most comprehensive mass production industry in the world. We are particularly fortunate that if we have to meet an emergency, we start from the satisfactory position that in the standards, in the methods and in the techniques of industry, there is complete interchangeability between us. We have ample supplies of most key materials required for peace or for war; and, for any potential shortages, there is capacity to develop acceptable substitutes; capacity too of perfecting and rapidly producing the newer and the better weapons of war as the occasion may require them for defense or for the fulfillment of our obligations under the United Nations.

It is not on numbers in the armed forces that we in North America depend for defense against any possible aggression, but on the more highly skilled and perfectly equipped forces by sea and land and in the air which our special advantages make possible—hard-hitting forces which can be mobile, far-reaching, and as matters stand, decisive in their power against any aggressor.

It is clear that if we ever are attacked, it is on "quality" forces and on "quality" weapons and equipment that we should place reliance. It is important that this be well remembered down the years and particularly by those entrusted with the conduct of negotiations for reductions in world armaments.

I think that in the period between World War I and World War II, both in Canada and in the United States, we learned the bitter lesson that unilateral disarmament is a delusion—a very expensive delusion that brought us very near to disaster and that cost us very dear in the lives of our young people. Just such a bitter delusion would be the surrender of any of the special weapons of great power, with which I include those based on atomic energy, until we have acceptable assurance through mutually applicable safeguards and an effective international system of inspection and control which carries our confidence that they, or their like, will not be used against us.

In these matters, the advantage of safeguards now possessed by the people of North America is not something which we could retain if we ceased to progress; or even if we allowed our industrial efficiencies to decline; then most certainly we soon would be overtaken and surpassed. The best protection for the countries of North America, as well as for the world, would be an effective organization of security under the United Nations, but, until this can be brought about, the continued production and further improvement of all of our weapons and the maintenance of industrial efficiency and preparedness are vital to the prevention of aggression by making impossible any prospect for its success.

THE FINAL OBJECTIVE

Until effective disarmament can be brought about, and until the aspirations of all nations can be harmonized by peaceful means, we will continue to need our armed forces, both as a deterrent to attack against ourselves and as an assurance to all other peace-loving nations, who think of us, that the peoples of North America remain strong and well able to help them. We of North America hold firmly to one final objective—a peace which will give security, justice, and opportunity for all. We are confident that success in this vital purpose will come eventually to men of good will who steadfastly pursue their course.

Electron Radiation Observed

In 1944 two Russian physicists, D. Iwanenko and I. Pomeranchuk, pointed out that radiation should come from the electrons moving in circular orbits in a betatron. This effect, they said, would impose a limit on the simple betatron. At more than approximately 100 million volts, the electrons would radiate energy as fast as they received it unless proper compensation were made.

Calculations indicated that such an effect should be observed from the electrons in the 100,000,000-volt betatron in the General Electric research laboratory, Schenectady, N. Y., and that some of the radiation should be of visible light. However, the doughnut-shaped section in which the electrons are accelerated, is lined with silver, making it opaque and thus preventing any observation.

The synchrotron doughnut, however, is lined with a transparent layer which is electrically conducting like the silver layer and carries away unwanted electric charges as they accumulate. From the General Electric research laboratory comes word that the predicted effect has been observed during the operation of the synchrotron. Electron light travels out in a beam half a degree in diameter, tangent to the orbit. It comes out ahead of the electrons. Thus, an observer looking at the doughnut from a point in the plane of the orbit, sees light from the electrons approaching him, but cannot see the light in any other part of the tube. Because of the curvature of the doughnut, the spot is distorted at present. However, a modified doughnut with a flat quartz window through which the effect may be seen more clearly is now in preparation. This will permit any part of the radiation that may fall in the invisible ultraviolet part of the spectrum to be photographed, as quartz, unlike glass, is transparent to these rays.

Though the effect is mainly of theoretical interest, the visibility of the electrons will be of use to scientists developing larger machines, in that they can locate accurately, within the vacuum enclosure, the tiny beam as it reaches higher energies.

Nature and Use of Piezoelectricity

W. G. CADY

Piezoelectricity means "pressure electricity." It refers to those electrical effects produced when certain crystals are compressed, and conversely, to the deformation of crystals in an electric field. Several hundred different crystals have been found to be piezoelectric, but the only ones that are of present practical importance are natural crystals of quartz and tourmaline, and artificial crystals of Rochelle salt and ammonium phosphate. Important uses of these crystals are described.

A PLATE cut from a piezoelectric crystal, mounted and ready for use, is an electric capacitor. Moreover, it is a motor and a generator as well. When the electrodes are connected to a source of alternating current, the crystal vibrates and can drive a mechanism such as a phonograph record cutter. When vibrated mechanically, it becomes a source of electric energy.

The word "piezo" is derived from the Greek word meaning "to press." Piezoelectricity is "pressure electricity," or electrification produced by mechanical pressure.

Piezoelectricity is found only in solid insulators possessing a certain particular property. In the language of mathematics the applied pressure, or more generally the applied stress, is a tensor consisting of a pair of equal and opposite forces, while the electrification, which appears primarily as an electric polarization throughout the volume of the material, is a vector. A tensorial cause can produce a vectorial effect only if the material itself is endowed with some sort of polar property in one or more particular directions. Although certain waxes, polarized electrically when solidified in a strong electric field, some day may become important in some piezoelectric applications, we shall not consider them here, but turn at once to those solids that are of greatest interest from the electromechanical point of view, namely crystals.

CONCERNING CRYSTALS

All crystals are anisotropic, which means that they have diffierent properties in different directions. The properties of chief interest in this paper are the elastic, dielectric, and piezoelectric. The higher the symmetry of the crystal, the more nearly do the properties approach those of such isotropic solids as well-annealed glass or plastics. In crystals of low symmetry such peculiar effects as the following can take place: a stretching force applied lengthwise to a rectangular plate not only may cause an elongation and a lateral contraction, but also give rise to one or more shearing strains, deforming the rectangle into an oblique parallelogram. An electric field applied in any given direction may cause a similar combination of strains. Moreover, in anisotropic solids the resulting electric displacement, or induction, may have components at right angles to the field as well as parallel to it.

The piezoelectric effect may be found in crystals belonging to 20 of the 32 crystal classes. In these 20 classes the symmetry is sufficiently low so that a force applied in the proper direction will cause an electric polarization, with liberation of equal and opposite electric charges.

An outstanding characteristic of piezoelectricity is that the electric polarization caused by a given stress is, at least under most working conditions, proportional to the stress and changes sign with it. This fact is illustrated by the crystal microphone and the phonograph pickup, in both of which devices variations in mechanical pressure give rise to alternating electric potentials. The production of electric polarization, and thereby of an electromotive force, by mechanical deformation, is called the direct piezoelectric effect.

Equally significant is the *reversible* nature of piezoelectricity. This is known as the converse piezoelectric effect. If a stress T produces a polarization in a certain particular direction, an electric field applied in this direction gives rise to a stress of the same type T, the stress being proportional to the field and changing sign with it. This dependence of sign of stress upon sign of field is what distinguishes piezoelectricity from *electrostriction.* The latter term applies to a universal characteristic of all dielectrics, whether gas, liquid, or solid, namely the property of undergoing a deformation, or change in volume, that is proportional to the square of the electric field strength, and which is therefore independent of the direction of the field. Electrostriction is usually so feeble that it can be neglected in comparison with the piezoelectric effect.

HISTORICAL

As a result of their study of the symmetry of crystals the brothers Pierre and Jacques Curie were led in 1880 to look for an electrical effect on compression of crystals possessing polar axes, the compression in each case being parallel to the polar axis. They found the direct effect

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Essentially full text of a conference paper "Piezoelectric Phenomena" presented at the AIEE winter meeting, New York, N. Y., January 27-31, 1947.

W. G. Cady is professor of physics at Wesleyan University, Middletown, Conn.

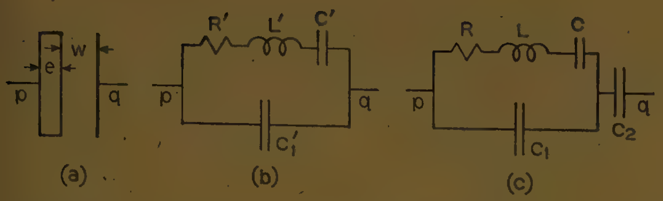


Figure 1. A crystal of thickness e with gap w, and its two equivalent networks: R, L, C, C_1 are the constants for the crystal without gap; C_2 is the gap capacitance; R′, L′, C′, and C_1' are the over-all constants including the gap

with a considerable number of crystals, including three of those that are most used today, namely quartz, tourmaline, and Rochelle salt. The converse piezoelectric effect was predicted on thermodynamic grounds by Lippmann, and promptly verified by the Curies.

Among the early investigators who became interested in this new phenomenon were Hankel, who coined the word "piezoelectricity"; Lord Kelvin, who suggested a molecular theory; Pockels, who made some of the early quantitative determinations and contributed to the theory; Duhem, whose formulation of piezoelectric principles was of fundamental importance; and finally Voigt, who systematized and extended the work of his predecessors, and whose monumental "Lehrbuch der Kristallphysik" contained practically all that was known about piezoelectricity until World War I.

The complete atomic theory of piezoelectricity is still in its infancy, although, thanks to the development of the theory of lattice structure and to X-ray analysis, some progress has been made. Among the more noteworthy contributions made be mentioned the theoretical estimate of the piezoelectric effect in quartz by R. E. Gibbs and of that in zinc blende by M. Born. In each case the predicted value of the piezoelectric constant was of the same order of magnitude as the experimental value.

Until World War I piezoelectricity was hardly more than a scientific curiosity. The modern phase of the subject was initiated by Paul Langevin, who conceived the idea of using the converse piezoelectric effect in plates cut from quartz crystals for generating a beam of ultrasonic waves in water. He recognized the importance of exciting his quartz-steel unit at a resonant frequency, thus paving the way for the later invention of the piezoelectric resonator and oscillator and their applications.

PIEZOELECTRIC CONSTANTS

Before dealing further with applications it is necessary to consider somewhat more in detail the piezoelectric effects in the various crystal classes. Since piezoelectricity is an electromechanical effect, we have to take into account both elastic and piezoelectric quantities. In elasticity six components of stress are recognized—three compressions, each parallel to one of the crystal axes, and three shearing stresses in different planes. Corresponding to these are six components of strain. Now in crystals belonging to the most unsymmetrical class, the triclinic asymmetrical, any one of the six components of stress produces an electric polarization having all three of its components different from zero. Thus there are 18 possible relations between the mechanical and the electrical states of the crystal. Correspondingly, there are 18 separate and independent piezoelectric strain constants, each of which expresses the relation between an applied stress component and the resulting polarization component, the latter being the electrical strain caused by a mechanical stress. Conversely, when an electric field is applied it acts as an electrical stress, each of whose three components gives rise in general to all six components of mechanical strain or stress. The coefficients expressing these relations are the 18 piezoelectric stress constants. Since the latter always can be expressed in terms of the elastic constants and the piezoelectric strain constants and vice versa, it is seen that the total number of independent piezoelectric constants for a triclinic crystal is 18. Considering the labor involved in measuring so many independent constants, it is perhaps fortunate that very few members of this asymmetric triclinic class are known.

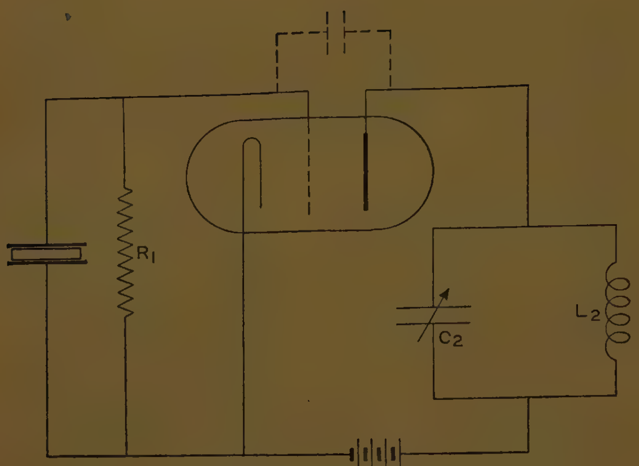
With all the remaining 19 piezoelectric crystal classes, the symmetry is sufficiently high to make some of the 18 piezoelectric constants vanish. In many cases some of the surviving constants have identical values, so that the number of *independent* constants is still further reduced.

The constants just discussed are the fundamental *piezoelectric* constants, expressed with respect to the fundamental crystal axes. Every crystal has also from 3 to 21 independent fundamental elastic constants. In oblique cuts the three principal dimensions of the cut constitute a new set of axes, rotated with respect to the fundamental axes. In terms of the new axes a new set of piezoelectric and elastic constants can be calculated from the fundamental constants and the angles of rotation. The advantages of oblique cuts will be treated later.

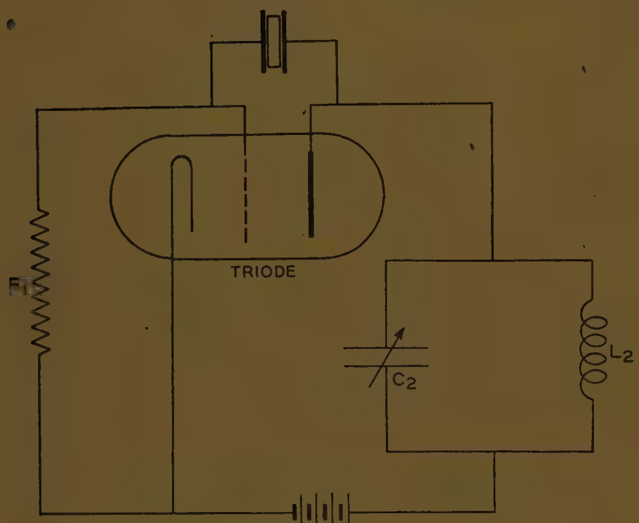
In experimental investigations and in practical applications many types of piezoelectric deformation are used. They include the elongation or compression of a crystal bar or plate; the bending (flexure) of a flat plate; the production of a shear (deformation of a rectangle into an oblique parallelogram) in a flat plate; and the torsion of a bar, plate, or cylinder.

SECONDARY EFFECTS

In general, piezoelectric crystals have different dielectric constants with respect to fields in different directions. If the dielectric constant of a given crystal is to be measured with the field in such a direction as to cause a piezoelectric strain, then unless the crystal is so clamped as to prevent the slightest deformation, some strain will occur. This in turn will give rise to a piezoelectric polarization in the same direction as that caused by the



A—The Pierce-Miller circuit



B—Pierce circuit

Figure 2. Piezo-oscillator circuits

R_1=*grid leak*
C_2L_2=*combination for adjusting the impedance in the anode circuit*

field, thereby increasing the observed value of the dielectric constant beyond that characteristic of the clamped crystal. This effect is, of course, greatest when the crystal is entirely unconstrained. It is therefore always necessary to state whether a given numerical value of the dielectric constant applies to the crystal in the clamped state, or free, or partially free. Such effects as this, where an interaction takes place between the direct and converse effects, are called "secondary effects."

A full discussion of secondary effects would involve not only mechanical and electrical quantities, but thermal as well. Thermal effects play a part, for example, in the phenomenon known as *pyroelectricity*. This phenomenon is found in certain crystals which become electrically polarized when heated, and it is closely related to piezoelectricity.

Secondary effects have to be taken into account in the measurement and specification of elastic constants. For instance, during the measurement of Young's modulus of a crystal bar, the surfaces may be kept at zero potential, as by having the bar coated with short-circuited metallic electrodes. In this case, although the crystal is strained and thereby polarized, there is no electric field to cause a secondary contribution to the piezoelectric strain, and the observed elastic constant is said to be that for zero field. On the other hand the bar may be devoid of electrodes, or its electrodes may be on open circuit. Then when it is stretched or compressed, the resulting polarization causes surface charges and hence a depolarizing field. This field in turn produces a new component of strain, thus modifying the value of the elastic constant.

We see thus that the mechanical state of the crystal must always be specified if definite values are to be assigned to the dielectric constants, and that the electrical state must be specified in connection with values of the elastic constants. These considerations are important in practical applications as well as in purely scientific studies.

THE CRYSTAL RESONATOR

This device, which is perhaps the most important piezoelectric application, depends for its operation on the secondary effects just described. The crystal preparation, usually called the "crystal," in the form of a plate, bar, or ring, suitably cut from the mother crystal, is placed between plane electrodes. The latter quite commonly are plated directly onto the crystal surfaces, but in some cases they are separated from the crystal by air gaps. From most piezoelectric crystals, notably quartz, preparations can be cut with natural vibrational frequencies that lie conveniently in the radio range. For example, one mode of vibration of a flat plate is that in which the thickness varies with a frequency f determined by the thickness t and the wave velocity v according to the equation $v=2tf$ for the lowest frequency (the fundamental frequency), or, approximately, $v=2tf/h$ for overtone frequencies, where h is an odd integer.

Quartz resonators have been constructed with frequencies all the way from 1,000 cycles per second (a flexural mode) up to about 200 megacycles per second (an overtone of a thickness shear mode). By "thickness shear mode" is meant a vibration in which the periodic strain is a shear, the direction of wave propagation being that of the thickness of the plate.

In the design and theory of piezo-oscillator circuits as well as in other applications of the crystal resonator it is customary to regard the crystal, when vibrating in the neighborhood of one of its natural frequencies, as replaced by a certain equivalent electric network. This network consists of a resistance R, inductance L, and capacitance C, all in series, while in parallel with this combination is the normal electric capacitance C_1 of the crystal considered as an ordinary dielectric (see Figure 1).

In quartz resonators the inductance L varies from the order of 0.1 henry with crystals vibrating at 1,500 kc per second, to 100 henries or more with low-frequency resonators. The capacitance C is of the order of only a few tenths of a micromicrofarad. It is this enormous ratio of L to C, a ratio utterly unattainable with any coil and capacitor combination, together with the relatively low resistance R, that gives to the piezoresonator its extremely low damping and high Q (ratio of stored to dissipated energy). In laboratory experiments with quartz, values of Q extending into the millions have been obtained, while in commercial service values of some hundreds of thousands are common.

When driven electrically at or near a resonant frequency, the crystal vibrates vigorously, and the strain causes a polarization, liberating electric charges which in turn react on the driving circuit. This reaction is analogous to the counter electromotive force in a motor. The crystal is a vibrational electric motor; but it vibrates effectively only in a narrow range of frequency, and by its reaction it tends to hold the frequency constant.

In every piezo-oscillator circuit the crystal acts fundamentally as a resonator. It does not generate energy, but by the electrical reaction of its vibrations it determines the alternating potential on the grid of the oscillating tube and thereby regulates the frequency.

The equivalent circuit of the crystal resonator has a frequency of series resonance, at which the electrical impedance is very low, and a frequency of parallel resonance (antiresonance) at which the impedance is very high. In the commoner forms of piezo-oscillator illustrated in Figure 2, the crystal operates at or near antiresonance. In some modern forms of oscillator series resonance is used.

SOME IMPORTANT PIEZOELECTRIC CRYSTALS

Piezoelectric properties have been detected in several hundred crystals belonging to various classes. Of them all only a few are in current use. Most of the rest are too scarce, or too small, or too deficient in such desirable qualities as insolubility, heat resistance, sufficiently large piezoelectric constants, and good elastic properties. For a long time quartz and Rochelle salt were the only ones of practical importance, though tourmaline was, and still is, put to limited use. In recent years crystals of ammonium dihydrogen phosphate (ADP) have been employed extensively, replacing Rochelle salt for many purposes. Several other crystal species have been found to have desirable properties that may lead to their practical application. At present efforts are being made in several laboratories to produce quartz crystals artifically as well as other kinds that may in time replace quartz, at least in some of its uses.

At present quartz is practically the only crystal suitable for the precise control of frequency in transmitting, monitoring, and receiving circuits. Quartz, the most abundant natural crystal, is chemically stable at all ordinary temperatures and has very low internal losses. It is this latter property that makes a quartz plate a very sharply tuned circuit element and accounts for its importance in piezo-oscillator circuits. The fact that it is only about a hundredth as strongly piezoelectric as Rochelle salt is outweighted by its high Q. Because some of its fundamental elastic constants increase with temperature while others decrease, it is possible, by cutting plates in certain oblique directions, to make resonators that have a zero temperature coefficient of frequency over a certain range of temperature. This comes about through the fact that, for any oblique cut, the elastic constant that controls the vibrations is the resultant of a group of the fundamental elastic constants.

These characteristics of quartz have led to its exclusive use for primary standards of frequency and as a means for stabilizing the 60-cycle frequency in power networks.

When one sees how simple in appearance a small quartz plate half an inch square and 20 mils thick is, it is hard to realize how much skill has gone into its design, and how much precise and costly equipment was required for its manufacture and testing. An excellent illustration of what can be accomplished in a democracy is the splendid co-operation between the scores of manufacturers of quartz plates and the Army Signal Corps in producing, on very short notice, the crystal equipment for hundreds of thousands of radio transmitting and receiving sets on land and sea and in the air, for the Armed Forces in the late war.

Rochelle salt, $NaKC_4H_4O_6 . 4H_2O$, not only is the most strongly piezoelectric of all known crystals, but it also has more complicated and puzzling anomalies than any other dielectric. Its dielectric properties are strikingly analogous to the ferromagnetic properties of iron. Below a certain temperature, which by analogy is called the Curie point, it exhibits dielectric hysteresis and has a free

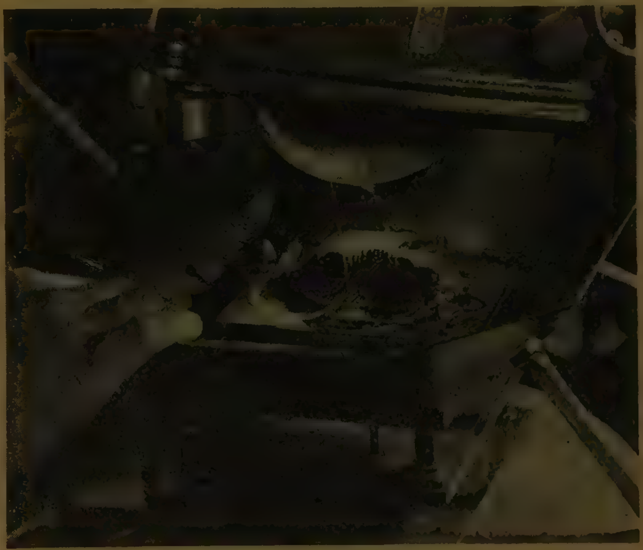


Figure 3. Improved diamond saw

dielectric constant that approaches infinity (with weak fields) at the Curie point. This point comes at about 24 degrees centigrade. But unlike ferromagnetic materials, Rochelle salt has also a "lower Curie point" at −18 degrees centigrade at which, with weak fields, the free dielectric constant again approaches an infinite value. This behavior occurs only with fields in the X-direction. The piezoelectric constant d_{14} shows similar characteristics. Outside the Curie points the crystal is still strongly piezoelectric, but its dielectric properties are analogous to the magnetic properties of iron that is in the paramagnetic state above its Curie point. The Curie points of Rochelle salt are subject to change by the application of pressure, and also by the substitution of heavy hydrogen (deuterium, D_2) for ordinary hydrogen in the crystal.

In most of the Rochelle salt applications mentioned in the following, the constraints imposed by the mounting tend to diminish the evil effects of changing temperature and of the nonlinearity that exists between applied voltage and strain. Nevertheless these effects cannot be avoided entirely. Considering them, and the fact that Rochelle salt tends to become dehydrated and that it disintegrates at 55 degrees centigrade, one easily can understand why for a long time the need has been felt for a crystal free from these objections, while still possessing a large piezoelectric effect.

This need is met in large measure by the use of the ADP crystals ($NH_4H_2PO_4$) mentioned before. Their piezoelectric and elastic properties are similar to those of Rochelle salt, but they are practically free from its anomalies at all ordinary temperatures, they have no water of crystallization to lose, and their melting point is about 190 degrees centigrade. Even though ADP is only about a fifth as strongly piezoelectric as Rochelle salt, it has replaced largely the latter in technical uses.

PIEZOELECTRIC APPLICATIONS

Devices employing piezoelectric crystals may be classified as resonant and nonresonant. We have already considered the resonator and its use in piezo-oscillator circuits. Mention should be made also of filter networks containing crystals as circuit elements. Here also the resonating property is utilized. For high selectivity quartz is used, but for broad-band filters Rochelle salt, ADP, and other crystals can serve well. When crystals of quartz or other material are used for generating ultrasonic waves they usually are driven at a resonating frequency in order to obtain the desired acoustic intensity with a fairly low voltage. Owing to the mechanical load imposed by the acoustic medium the damping is relatively large, so that sharp tuning is unnecessary.

The crystal ultrasonic generator is one form of *transducer*, by which is meant a device for transforming electric into mechanical energy or the reverse. Most of the transducers to which we now turn are of the nonresonant type. Because resonant frequencies are usually to be avoided, considerable damping in the crystal and its mounting is allowable. What is much more essential than low damping is a large piezoelectric constant. For this reason Rochelle salt or ADP is generally to be preferred to quartz.

A crystal transducer operates sometimes as a motor, and sometimes as a generator. In the first class are included such devices as the crystal telephone receiver and loudspeaker, the phonograph record cutter, and the crystal oscillograph. The crystal converts mechanical into electric energy in microphones, pickups for phonographs or musical instruments, hydrophones, and vibration meters.

In all such devices as these the amounts of energy converted are very small. A crystal of reasonable size vibrated mechanically would break under the stress long before it produced enough current to light a lamp continuously. A brief flash of light, however, can be observed when a sudden blow is given to a Rochelle salt crystal connected to a neon lamp.

In conclusion we will allow ourselves to indulge in a flight of the imagination and design a piezoelectric generator for generating approximately 100 watts of power at 60 cycles per second. The crystal is to be in the form of a quartz plate two millimeters thick cut perpendicular to the X-axis—the "X-cut". The two faces of the slab are plated with metallic electrodes connected to an external resistance R. A periodic force, uniformly distributed over the upper face of the slab, is applied at a frequency of 60 cycles per second, while the crystal rests on a rigid base. The peak value of the compressional stress is to be 10^8 dynes per square centimeter (about 100 kilograms per square centimeter). This stress is chosen because it allows a good factor of safety. The 60-cycle voltage thus produced will decrease from 1,200 volts to zero as R diminishes from infinity to zero. For a given value of R the voltage, and therefore the current supplied to R, will be greater the larger the area of the crystal. A little calculation shows that in order to send a current of one ampere through a resistance of 100 ohms the area would have to be of the order of 1,500 square feet! In view of the scarcity of crystals of this size, one might make an assemblage of 220,000 plates, each one inch square, all connected in parallel, at a cost of a million dollars. They might be assembled in layers piled one on top of another, forming a column a foot square and ten feet high. If this could be done, and if the hypothetical alternating pressure could be applied, and if there were no frictional and other losses in the column, a current of one ampere would flow through the external resistance of 100 ohms. To produce the necessary compression the amplitude of motion would be about 1/64 inch. The maximum force would be over 100 tons. From these remarks, and considering the small power factor and low efficiency of such a device, it is evident that the power companies need not dread greatly competition from crystals as a source of electric energy.

Metallic Rectifiers for Motor Power Supply

F. L. REED

Metallic rectifier power packs have been in operation for about 18 months at the Buffalo, N. Y., plant of the Westinghouse Electric Corporation. The rectifier units fill the need for supplying d-c power for small d-c motors in scattered areas, and are claimed to have lower cost and higher efficiency than motor generator sets, with easier mounting and simplified maintenance.

METALLIC rectifiers are practical for converting alternating to direct current for operating constant or adjustable speed motors. This conclusion has been reached following several years of laboratory tests coupled with 18 months actual operating experience in the Buffalo plant of the Westinghouse Electric Corporation where they supplied d-c power for small motors in scattered areas.

For the range of sizes from 1 to 15 horsepower the cost is less than that for a motor generator set, efficiency is higher, regulation is essentially the same, commutation is not adversely affected, mounting is not as much of a problem, and maintenance is simplified.

The power pack itself uses a selenium cell rectifier to convert the available a-c power supply into direct current. Selenium is used because it is possible to keep the physical size and weight smaller than for a copper oxide rectifier or a motor generator set. Control is reduced in many applications to a standard a-c line starter and a field rheostat, and the entire installation is a simple one as the power pack can be mounted in any out-of-the-way place.

Six sizes have been developed; 1-, 3-, 5-, $7^{1}/_{2}$-, 10-, and 15-horsepower ratings. These are available for 230-volt d-c output and the source of power can be any of the conventional a-c 3-phase system voltages normally found in industrial plants. The small size power packs (1, 3, and 5 horsepower) are of the self-cooled type and consist of an autotransformer and a rectifier assembly. The autotransformer makes it possible to use any a-c system voltage and, by suitable choice of transformer, the d-c output will be 230 volts at full load. In the larger sizes ($7^{1}/_{2}$, 10, and 15 horsepower) the rectifier cells are air-cooled by a self-contained fan that is driven by a fractional horsepower a-c motor. A protective thermal relay opens the circuit if the fan does not operate. Figure 2 shows the schematic diagram of this unit.

When using the rectifier, the conventional d-c control can be supplied; but a simplification is possible by taking advantage of the natural internal resistance of the rectifier. It is possible on the 1- – $7^{1}/_{2}$-horsepower sizes to dispense entirely with the d-c control and retain only the field rheostat. A simple safety switch or magnetic circuit breaker can be installed in the a-c line for starting and stopping the motor and it is possible to line start the motor through the rectifier even when the shunt field rheostat is set to give a speed of four times the base or full field speed. Where dynamic braking or reversing is required, a similar simplification of control is possible by omitting the fluttering relay on the shunt field, the starting resistance, and all the relays and contactors associated with the starting resistance. Such a simplification, as applied to a standard motor used for nonreversing service but requiring dynamic braking, is illustrated in Figure 3. This type of control can be used on punch presses where dynamic braking is desirable to position the press when setting up the dies.

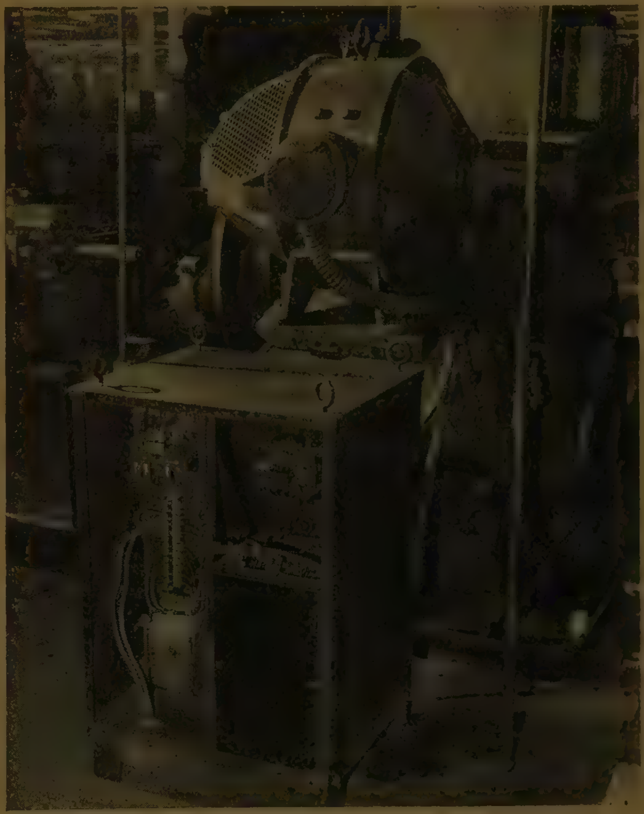


Figure 1. Forced cooled selenium cell power pack for 15-horsepower motor used to drive machine tool

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Essential substance of a District paper, "Oxide Rectifiers as a Power Supply for D-C Motors," presented at the AIEE North Eastern District meeting, Worcester, Mass., April 23–25, 1947.

F. L. Reed is engineer, d-c engineering, motor division, Westinghouse Electric Corporation, Buffalo, N. Y.

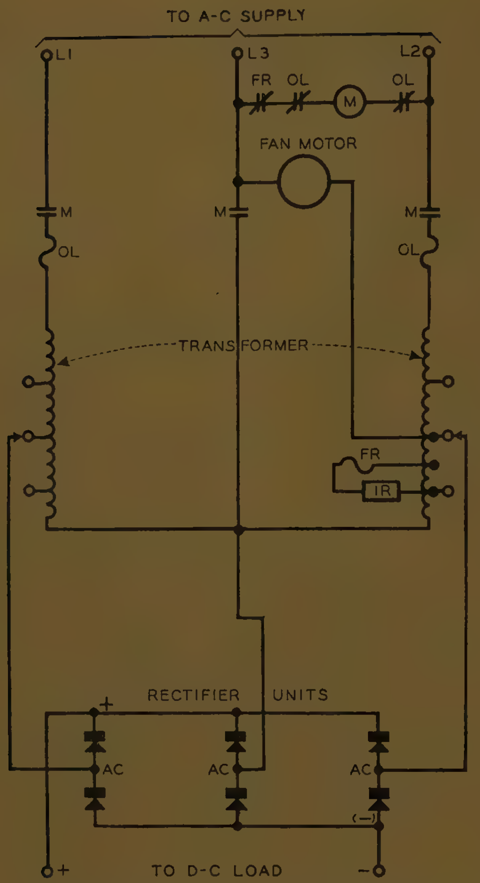

Figure 2. Schematic diagram for selenium cell power pack for $7^1/_2$-, 10-, and 15-horsepower motors

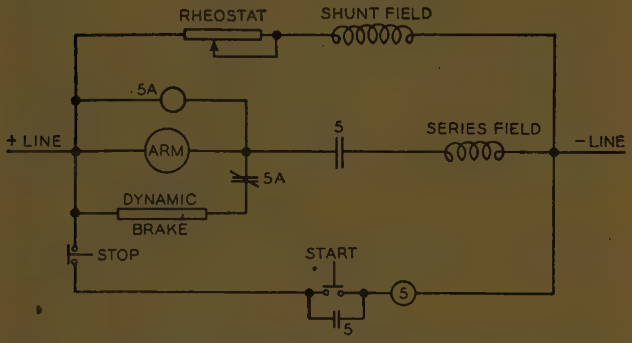

Figure 3. Schematic diagram for simplified control for use with motors on selenium cell power packs

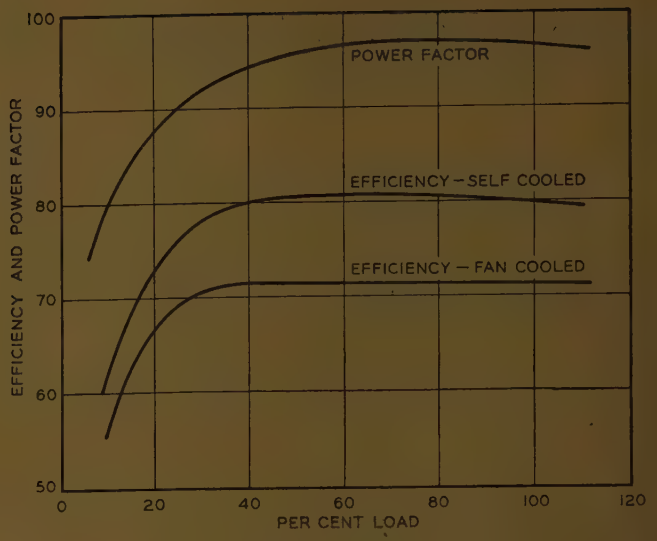

Figure 4. Efficiency and power factor curves of selenium cell power pack for operating adjustable d-c motors

Typical rectifier performance curves are shown in Figure 4. The performance of the rectifier is very much better than can be obtained with a motor generator set whose maximum power factor is approximately 85 per cent and whose over-all efficiency will not exceed 60 per cent in the 1- to 15-horsepower ratings. Voltage regulation of the rectifier is about the same as would be obtained from a motor generator set. Speed regulation of an adjustable speed motor is essentially the same as for a standard drive when operated from the rectifier.

Commutation is another of the major considerations in the operation of a d-c motor. The voltage supplied from a rectifier is not a steady voltage as obtained from a d-c generator; instead, it pulsates from the a-c supply. These pulsations are at a frequency six times the supply frequency for a 3-phase system. The pulsation magnitude is approximately $4^3/_4$ per cent of the average rectified voltage. These pulsations might cause a disturbance to the commutation which is always critical on an adjustable speed motor. However, tests and shop experience prove that commutation is not adversely affected by the rectifier supply. On the motors that were line-started from the rectifier there was a noticeable "sparking" at the brushes, but many rapidly repeated starts did not cause any burning of the commutator bars, even when the motor was line-started at weak field.

In deciding on the proper choice of power supply many factors must be considered. Several are immediately evident, such as: initial cost, installation, maintenance, and continuity of service.

The initial cost of the rectifier power pack is not established firmly yet. However, just as the price of a motor generator set varies approximately as the square root of the kilowatt rating, it varies almost directly for the rectifier. From this it is evident that on small sizes the rectifier drive will have a price advantage that it will lose on the larger ratings. Up to about 15 horsepower the rectifier power pack is competitive with the motor generator set; beyond this it loses its price advantage.

The rectifier has an advantage over the motor generator set on installation and maintenance because it is smaller and its location is not critical. It can be mounted up out of the general floor area so it does not take up valuable floor space. Lack of rotating parts, except for the fan in forced cooled units, permits a wider range of locations for mounting. The rectifier unit requires little attention by the maintenance personnel as there are very few parts.

Modern Ocean Cable Telegraphy

C. H. CRAMER
MEMBER AIEE

Transmission on long nonloaded submarine telegraph cables has been improved by application of efficient signal-shaping amplifiers, replacement of electromechanical receiving equipment, use of new artificial line networks and new methods of balancing, and increased sending voltages. With these improvements it became practicable to change from cable code recorder operation to printer operation and, at the same time, to obtain higher quality of transmission at increased speeds.

LIMITATIONS of the earliest methods of cable operation were determined largely by the available operating equipment. The receiving instrument first used on the transatlantic cables was the mirror galvanometer. By reason of its sensitivity and favorable signal-shaping characteristics, the moving-coil type of receiving equipment remained in a dominant position in nonloaded cable operation until relatively recent years. Application of these developments and the regenerative repeaters which followed, extending over the years to the period immediately following World War I, brought about substantial increases in signaling speeds.

Because of the fragility of the moving-coil equipment and the gain limitations of the magnifiers, the potentialities of the vacuum tube in ocean cable telegraphy were recognized early in the development of the electronic art. High disturbance levels generally existent on duplexed nonloaded cables and lack of electric networks with practical shaping and discrimination characteristics presented difficulties which subsequently disappeared when improved magnetic materials and electronic components became available.

The continuously-loaded telegraph cable, with its promise of considerably higher signaling speeds, emphasized the limitations of recorder operation and electromechanical terminal equipment. Necessity thus brought about the concurrent development of a signal-shaping amplifier and a multiplex printer system suitable for high-speed loaded-cable operation.

Following the period of preoccupation with loaded-cable developments, and as the success of the new operating methods and equipment became evident, efforts toward improvement in the operation of the nonloaded cables were renewed. The end results of these developments, which now may be regarded as substantially completed, have been applied successfully to a considerable extent in the North Atlantic cable system of the Western Union Telegraph Company. Installations were intensified during World War II, in the course of which the developments were made available to the Commercial Cable Company and were utilized in the rehabilitation and extension of the cable system of the Alaska Communication System.

The program has included conversion from cable code recorder operation to 5-unit code printer operation; the replacement of magnifiers with vacuum-tube signal-shaping amplifiers which also makes possible use of sturdy land-line-type polar relays instead of the mechanically-delicate cable relays; and improvements in duplex artificial line networks and in the technique of balancing. In addition, circuit speeds have been increased and circuit and equipment maintenance at the cable stations have been reduced through more completely automatic operation.

PRINTER SYSTEM

In view of the high capital cost of the long nonloaded ocean cable and its relatively low signaling speed, the message output of the circuit is a matter of great importance, and thus it is ordinarily essential to use a signaling code with a minimum number of time units per character. For this reason much work has been done on cable printer systems based on various nonuniform codes which average fewer units per character than the Baudot 5-unit uniform code. However, early experiments with printer operation on Western Union cables, confirmed by ex-

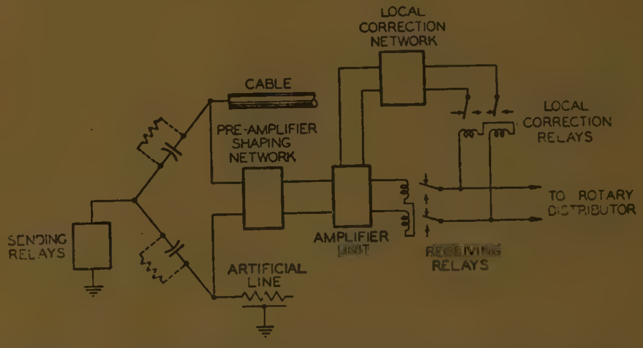

Figure 1. Typical application of signal-shaping amplifier on duplexed nonloaded cable

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Essential substance of paper 47-79, "Some Modern Techniques in Ocean Cable Telegraphy," presented at the AIEE winter meeting, New York, N. Y., January 27–31, 1947, and scheduled for publication in AIEE *TRANSACTIONS*, volume 66, 1947.

C. H. Cramer is assistant transmission research engineer, Western Union Telegraph Company, New York, N. Y.

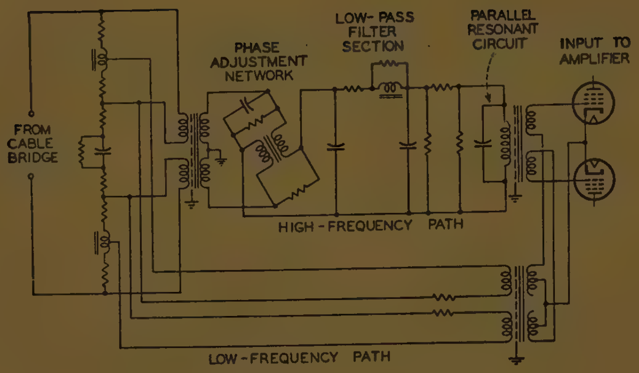

Figure 2. Preamplifier signal-shaping network

perience with the loaded-cable circuits, favored the adoption of the 5-unit code with a method of transmission, used also on the loaded cables which effectively overcomes the relative inefficiency of the code.

The printer system which has been standardized for nonloaded cables does not differ fundamentally from the loaded-cable system but it resembles the land-line multiplex more closely.

A cable printer system has all the elements of flexibility of the land-line multiplex; that is, individual channels may be terminated, extended, or combined with other channels as required to meet traffic conditions and the transmission speeds of the available circuits. Varioplex methods may be applied to obtain subchannels for use as direct point-to-point or customer-to-customer circuits where the full capacity of a channel is not required.

SIGNAL-SHAPING AMPLIFIER

Requirements of a signal-shaping amplifier which will permit satisfactory printer operation on long nonloaded cables at the highest practicable speeds are severe. The more important of these are

1. A higher standard of accuracy, continuity, and reliability of operation now is required.

2. The signal-shaping network must equalize or restore the signal components to an approximation of the original amplitude and phase relationships.

3. The shaping network must pass only the narrowest band of frequencies consistent with a satisfactorily low degree of characteristic distortion.

4. In the case of duplex-operated cables, the shaping network should be electrically symmetrical with respect to the duplex bridge or electrically isolated from it so that the network and the amplifier do not contribute, of themselves, to the duplex unbalance.

5. The network elements must be provided with a considerable degree of adjustability.

6. The amplifier should be provided with sufficient gain and output to operate rugged polar relays of the general type standard in land-line telegraphy.

The signal-shaping amplifier which now is regarded as standard for long nonloaded cables meets the requirements detailed in the foregoing and may be viewed, at least for the present, as a satisfactory conclusion of several years of laboratory development and field operating experience. A standard installation, Figure 1, includes a primary or preamplifier shaping network, an amplifier unit, receiving relays, and a secondary shaping or local correction network which supplies low-frequency components of the signals rejected by the preamplifier network.

When correctly adjusted, the preamplifier network (Figure 2), passes a band which includes all of the higher-frequency components of the signals required for good signal shape, properly proportioned and phased. Frequencies below the fundamental received frequency are heavily attenuated, with almost complete rejection in the range of earth current disturbances.

The 3-stage resistance-capacitance-coupled amplifier is of a push–pull type with two stages of voltage amplification. The output of the amplifier is adequate for the operation of modern land-line-type polar relays. Following usual cable practice, the normal receiving relay circuit comprises a pair of standard 2-position relays functioning together as a 3-position relay. This circuit is converted readily for optimum reception of 2-current signals.

Shaping involving local correction, while considerably refined in the present application, is not new. It normally was utilized in some degree in the magnifier shaping systems. It differs from the method employed in the loaded-cable amplifiers in which essentially all shaping is accomplished in preamplifier and interstage networks with, however, some deficiency in the very-low-frequency components. The advantages over the latter method include, in addition to the relative immunity from low-frequency disturbances mentioned previously, simplification of amplifier design and increased amplifier stability. Also, the received signals are not subject to "wandering zero."

DUPLEX OPERATION

As duplex operation of nonloaded cables normally affords greater total message capacity, that method is usual unless abnormal transmission and traffic conditions favor 1-way operation. The importance of duplex unbalance as a limiting factor has been reduced in recent years through improvements in artificial line networks and balancing methods.

THE DUPLEX BALANCE

The basic ocean cable artificial line has changed little in form since the early days of duplex operation. The lumped series resistance and shunt capacitance elements, simulating the conductor resistance and the capacitance of the cable, have varied somewhat over the years.

Although the basic artificial line simulates directly only the d-c resistance and the capacitance of the cable, the circuit parameters include inductance and effective resistance which vary with frequency because

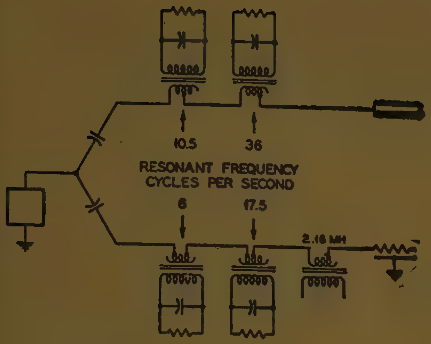

Figure 3. Typical installation of resonant balance networks

of the characteristics of the earth return path, and commonly are termed the sea-return impedance. These factors, generally of minor effect on signal transmission, are of considerable importance in balancing. Inductive networks have been added to artificial lines but have not proved to be a satisfactory method for obtaining balances of the order of accuracy now demanded.

For a simulated sea-return impedance the uniform network is not a complete answer, but it can be applied to a very limited extent at the head of the artificial line with some beneficial results at the frequencies requiring the greatest accuracy of balance. Another factor which limits the use of the network is that its propagation constant differs substantially from that of the cable and hence affects the balance of the following sections of artificial line, particularly as the cable commonly is not uniform.

More recently it has been found that, if in the artificial line the resistances in series with the parallel capacitors are tapered, the sea-return impedance is simulated over a relatively wide band of frequencies, and further that there is no important change in the propagation constant of the section of artificial line to which it is applied.

With the uniform network, reduction of the unbalance is accomplished by a series of time consuming cut-and-try compromise adjustments which frequently result in a considerable distortion of the resistance-capacitance ratio in some sections of the artificial line.

In the instance with tapered resistors, refinement of the balance is less difficult, requires less time, and a final balance of great accuracy can be obtained.

UNBALANCE AND CORRECTIVE NETWORKS

The conventional method of balancing involves transmission of slow reversals and observation of the residual unbalance transient by oscillograph or ink recorder while adjusting the artificial line. In the final stages of the adjustment, unbalance resulting from transmission of signals at operating speeds also is observed. Adjustment in this manner of the basic artificial line or any of its modifications eventually reaches a point where further reduction of the unbalance becomes impracticable.

These barriers have been lowered by a new approach to the problem in which corrective resonant networks are applied, each supplying an impedance which can be controlled effectively as to magnitude and width of frequency band. The networks are designed in accordance with a frequency characteristic of the residual unbalance.

The frequency characteristic which is the basis of the method may be obtained by a mechanical harmonic analysis of an oscillographic record of the unbalance transient, or the effective residual impedance unbalance at the head of the artificial line may be measured directly across the duplex bridge through the important frequency range. The electrical measurement, which now is used exclusively in practice, requires considerably less time and it is more accurate as extraneous interference is rejected by sharply selective filters.

Final balance following the insertion of the preferred network, of the parallel-resonant type, is obtained by minor adjustments of the usual artificial line controls. An important further advantage of this method of balance refinement is that the work may be carried on without disturbing the existing operating balance, so that the circuit may be returned to operation quickly if required. Also, the networks can be designed and checked to a large extent independently of the cable circuit and thus without interruption of circuit operation.

While the frequency-analysis technique is essential in the design of resonant balance networks, it has proved to be very valuable in balancing work generally. For example, development of the tapered sea-turn impedance correction would have been difficult if not impracticable if the study had been limited to transient effects.

The cathode-ray oscilloscope, when provided with the slow sweep necessary for the very low frequencies encountered, has proved to be an important and versatile adjunct in balancing work. Compared with electromechanical types of oscillograph, it is more convenient to use and reduces the time required for balancing because the effect of an adjustment can be observed immediately.

INTERFERENCE

Crossfire between cables is not unusual where two or more cables land at the same point and, of necessity, may be laid with small separation between cables. Such interference is controlled readily by use of simple corrective networks at the cable stations.

With the means now available for improved balances and for correction of crossfire, extraneous interference, mostly of natural origin, becomes, in general, the most important factor preventing further increases in speed. Natural interference is picked up in the shallow-water end section of cable and its magnitude, depending upon the depths and distances encountered, varies widely from cable to cable.

Some improvement has been obtained by increasing the sending voltages which, until recent years, were restricted conservatively to about 50 volts. In the Western Union cable system potentials of 90 to 120 volts are now in common use, and a much better signal-to-interference ratio exists.

Electrical Standardization and AIEE

H. E. FARRER
MEMBER AIEE

The complexity of the diagram of Standards committee procedures indicates that it is one of the busiest of AIEE committees. That it is one of the most far reaching in influence is apparent from this concise assessment of the magnitude of the committee's task in promoting uniform and sound engineering standards governing the applications of electricity.

THE HISTORY of standardization in the AIEE goes back nearly 50 years to the appointment in 1898 of the first committee on standardization. Over the ensuing half century, the AIEE has supplied cooperative leadership in setting the standards of electrical engineering, sharing the responsibility of standardization with other national engineering societies in related fields. One of the most momentous of its undertakings had its beginnings 30 years ago when the Institute and four other national engineering societies formed the American Engineering Standards Committee, which developed into the present American Standards Association. A more detailed perspective of standardization history can be gained from the accounts prepared for the 50th anniversary issue of *ELECTRICAL ENGINEERING*.[1,2]

In the last two decades, the techniques of electricity have multiplied so prolifically that there now are many more organizations interested in the development of electrical standards and in the industrial economy which depends upon them. While AIEE remains the leader in the field, co-operation has been the practice, and indeed is essential, if overlapping and duplication are to be avoided. With full realization of the many diversified interests to be served, the AIEE endeavors in its standardization work to consider the interests of others, as well as itself, and to conduct its projects in such a way as to minimize changes when other organizations join in the work.

THE STANDARDS COMMITTEE—ITS FUNCTIONING AND ACCOMPLISHMENTS

The Standards committee is one of the general committees of the Institute, but, as much of its work is technical, the chairmen of the technical committees are ex-officio members of the Standards committee. The actual work of preparing or revising standards usually is assigned to co-ordinating committees, to special subcommittees, or to the technical committees concerned. The Standards committee further is empowered to refer projects to ASA sectional committees, joint committees of AIEE technical committees, or joint committees of AIEE and other organizations. Reference to a technical committee is the preferred procedure, however.

Created in 1939, the co-ordinating committees encompass standards work broader in nature than that falling within the scope of single technical committees. The titles of the following co-ordinating committees indicate the sort of function they perform:

1. Reference values for Standards.
2. Standard voltages and currents.
3. Surge testing and insulation.
4. Basic principles for rating of electric machinery.
5. Basic theories and units.
6. Interferences, sound and vibration problems.

Besides synthesizing the data and work of the AIEE technical committees to eliminate duplications and inconsistencies, the co-ordinating committees make recommendations through regular Standards committee procedures to the ASA, the International Electrotechnical Commission, and other standardization bodies for the purpose of bringing about maximum uniformity of standards for the whole of the electrical science and industry. The detailed work of reviewing standards and reports submitted to the Standards committee for approval also is done by the co-ordinating committees.

Appropriate procedures for all AIEE groups involved in standardization work are laid down in the "AIEE Standards Manual" which has been revised within the past year. Interested members may obtain copies from Secretary H. E. Farrer at AIEE headquarters. An appendix to the manual, by Past President F. M. Farmer, sets forth the general policy of the Institute with respect to the development and publication of standards in the field of electrical engineering. Failure to observe the procedures laid down in the Standards manual, for example, independent action on the part of AIEE technical committees or committees within the Sections, is likely to lead to duplication of effort or inadequate representation of those properly concerned. Even though a technical committee clearly may be qualified to prepare a given standard, initiation, approval, and publication of such a project needs the auspices of the Standards committee. It represents the board of directors in co-ordinating all Institute standards activity.

H. E. Farrer, member of the AIEE headquarters staff since 1923, is secretary of the AIEE Standards committee.

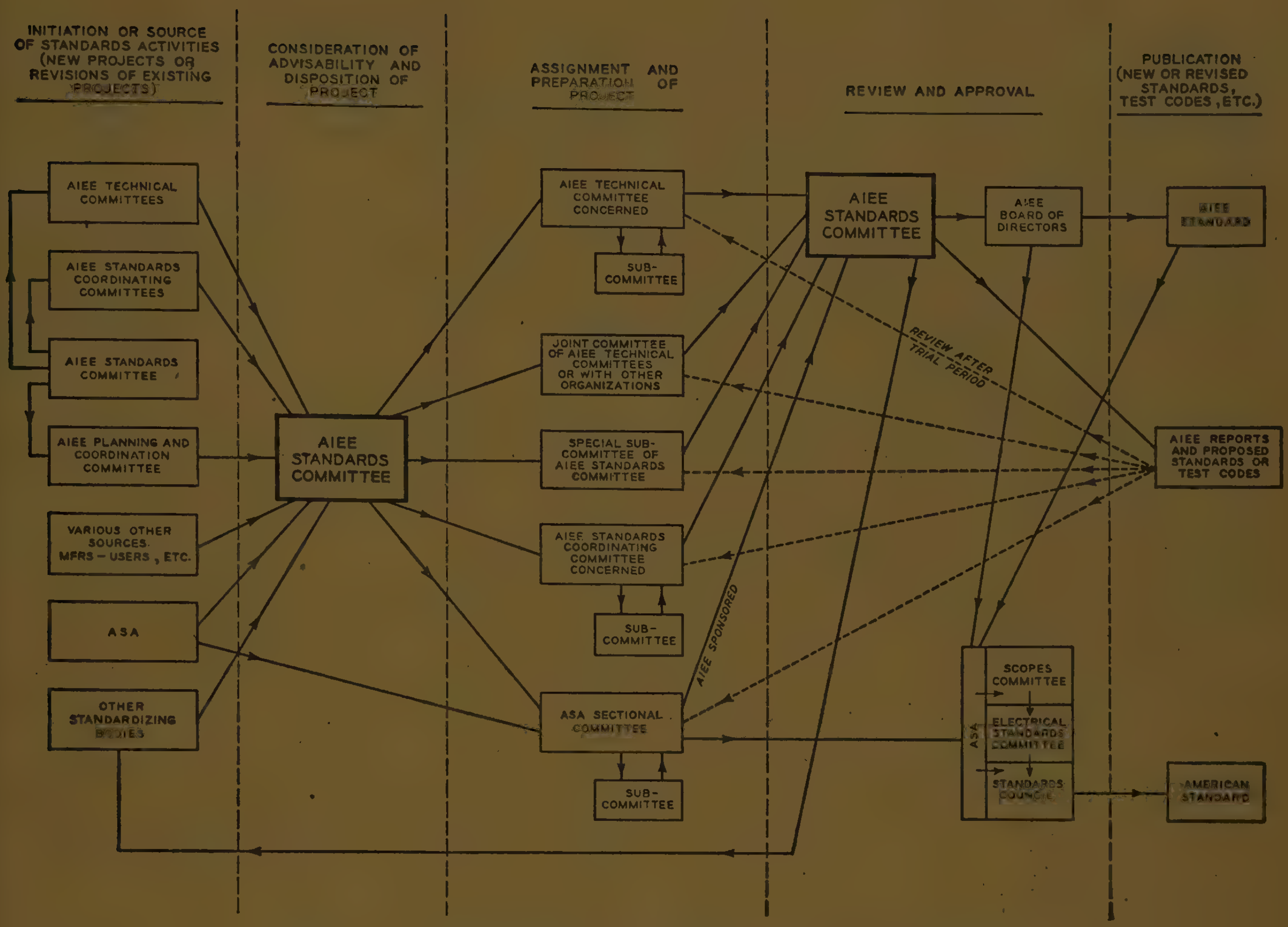
INITIATION OR SOURCE OF STANDARDS ACTIVITIES (NEW PROJECTS OR REVISIONS OF EXISTING PROJECTS)
CONSIDERATION OF ADVISABILITY AND DISPOSITION OF PROJECT
ASSIGNMENT AND PREPARATION OF PROJECT
REVIEW AND APPROVAL
PUBLICATION (NEW OR REVISED STANDARDS, TEST CODES, ETC.)
AIEE TECHNICAL COMMITTEES
AIEE STANDARDS COORDINATING COMMITTEES
AIEE STANDARDS COMMITTEE
AIEE PLANNING AND COORDINATION COMMITTEE
VARIOUS OTHER SOURCES. MFRS – USERS, ETC.
ASA
OTHER STANDARDIZING BODIES
AIEE STANDARDS COMMITTEE
AIEE TECHNICAL COMMITTEE CONCERNED
SUB-COMMITTEE
JOINT COMMITTEE OF AIEE TECHNICAL COMMITTEES OR WITH OTHER ORGANIZATIONS
SPECIAL SUB-COMMITTEE OF AIEE STANDARDS COMMITTEE
AIEE STANDARDS COORDINATING COMMITTEE CONCERNED
SUB-COMMITTEE
ASA SECTIONAL COMMITTEE
SUB-COMMITTEE
AIEE SPONSORED
AIEE STANDARDS COMMITTEE
AIEE BOARD OF DIRECTORS
REVIEW AFTER TRIAL PERIOD
ASA
SCOPES COMMITTEE
ELECTRICAL STANDARDS COMMITTEE
STANDARDS COUNCIL
AIEE STANDARD
AIEE REPORTS AND PROPOSED STANDARDS OR TEST CODES
AMERICAN STANDARD

Figure 1. AIEE procedure in development of electrical standards

The Institute's committee setup, both the technical and Standards, responds quickly to the needs of the engineering field. Differences of opinion on technical matters, often resulting in long delays in more formal organizations frequently can be thrashed out with a minimum expenditure of man-hours. Progress is reported from time to time in *ELECTRICAL ENGINEERING*, and current publications are listed several times annually, so that a maximum dissemination of knowledge of AIEE standardization work among working engineers is effected. AIEE, therefore, must keep a vigilant eye on standardization needs and undertake through early action by the Standards committee to set up the necessary machinery to meet requirements as soon as conditions warrant.

However, some standards matters, it generally is conceded, logically belong solely within the AIEE sphere of action. Examples of such projects are: the establishment of reference standards for temperature, pressure, and humidity; the development of standard methods of testing (test codes) to permit equitable comparisons of performance characteristics of electric apparatus within the limits specified in the standards.

At present the Institute has in good standing more than 50 published Standards, reports on proposed standards, test codes, recommended specifications, and guides to good practice. During 1946 the following standards, codes, and guides were approved:

1. Revised edition of Standard 1, "General Principles Upon Which Temperature Limits Are Based in Rating of Electric Machines and Apparatus."
2. Standard 32, "Neutral Grounding Devices."
3. Standard 40, "Electrical Recording Instruments."
4. Standard 700, "Aircraft D-C Apparatus Voltage Ratings."
5. Report 6, "Pool Cathode Mercury-Arc Power Converters."
6. "Master Test Code for Resistance Measurements."
7. "Aircraft Electric Systems Guide."

For an excellent illustration in which all phases of standardization development are embodied—basic development work by AIEE and the proper co-ordination of that work with related activities in other organizations—reference can be made to present AIEE undertakings in the aeronautical field—a virgin field calling for the formulation of standards, test codes, reference limits—all now going forward in effective co-operation with such other interested organizations as the Society of Automotive Engineers, the National Aeronautical

Standards Committee, the Aeronautical Board of the Navy Department, and the Aircraft Industries Association of America.

Regardless of which organization sponsors a standard, the Institute provides "a forum for the presentation of reports, papers, and discussions applying basic information for standards projects in the electrical field."[3]

ASA AND AIEE

The ASA today is a federation representing more than 100 national associations and government departments and 2,000 companies. Through it, the technical societies, government, industry, distributors, labor, and consumers work together to obtain mutually satisfactory results. Not intended to be primarily a *standards-making* body, the ASA operates on "the basic philosophy that in order to have a standard labeled 'American Standard' it must be a matter of record that an affirmative consensus of all interests substantially concerned with its provisions has been attained."[3]

ASA's co-operative undertakings in general cover a wide variety of standardization which can be classified roughly as follows: Nomenclature (definitions, abbreviations, letter symbols, graphical symbols); dimensional uniformity, quality specifications; methods of test, ratings of machinery and apparatus; safety provisions; process and operation standards; optimum number of sizes, types, and grades.

Within ASA, standardization generally is carried on by sectional committees, composed of officially accredited representatives of the organizations substantially interested in the projects. These committees are selected to insure a balance, so far as practical, between manufacturers, consumers, and general interests. They usually are supervised by administrative sponsors. The make up of the committees, as well as the content of any proposed American Standards, codes, practices, and so forth, developed by them, must undergo the rigid tests specified in detail in the rules of ASA as to competency of the originating committees and acceptance of the developed projects by those chiefly concerned with their provisions.

Although the ASA is ruled by a council on which all member bodies are represented, the work of the association has expanded into so many fields that industry committees have been formed to co-ordinate allied projects. Most of the technical work of standardization is accomplished through these committees or subcouncils. AIEE, for instance, is most concerned with the projects of the Electrical Standards Committee. Other such committees are the Mechanical Standards Committee, the Building Code Correlating Committee, and the Safety Code Correlating Committee.

Two other special procedures for obtaining approval as American Standards are available—existing standards method and general acceptance method. In the first instance any existing standard may be approved by ASA, if it is shown that it has the approval of those concerned with its scope and provisions. The second method (general acceptance) covers simple projects where the setting up of formal committees is not considered necessary. Approval in such instances is obtained by means of conferences of those concerned, supplemented by written acceptances. What is called the "proprietary method" is applied to revision of standards that have been approved by ASA.

As stated previously, AIEE standardization machinery provides a fairly informal means for doing, with minimum effort, the spade work so necessary to proper development of standards. When that task is accomplished in a given field, the question arises, "Should the project be referred to ASA for further consideration and action; if so, when?" The factors which govern that decision vary so widely that no definite rule for action can be set down. When the project fits into the scope of an existing sectional committee of ASA it usually is passed along immediately to the sectional committee. If, however, the proposed standard, code, or guide covers an entirely new development, experience has proved it advisable to have AIEE publish it in pamphlet form, clearly indicating the status of the material covered. By this means, industry can be advised of what is proposed, and every opportunity is given for obtaining suggestions and criticism within a stated period. At the expiration of the probationary period, the project is frequently ready for immediate formal action by the Institute and ASA.

With the growth of the ASA, the Institute's activity probably has been greater rather than less. However, much of it is in co-operation with other bodies and in sectional committees, and therefore is less conspicuous as an AIEE project. Nevertheless, the AIEE as sponsor for many sectional committees bears a major portion of the burden of the work.

INTERNATIONAL STANDARDIZATION

The necessity for pooling economic resources and interchanging and co-ordinating equipment and supplies forcefully impressed upon the Allied Nations during World War II the great value of standardization, and to alleviate their predicament, the United States Standards Co-ordinating Committee was formed. Although the war ended before the committee was fully under way, it is continuing for an indefinite time, and its activity is directed toward laying the foundation for postwar co-operation in standards for international trade.

In the history of international standardization, it is noteworthy that some of the earliest work was done in the electrical field. The AIEE has taken an active part in the work of the International Electrotechnical Commission since its inception in 1906.[4] This has been done not only through appointed representatives in various IEC committees dealing with electrical standardization, but also through the work of administering the secretary's office of the United States National Committee of the IEC, which the AIEE did for many years.

After World War I the advantages of standardization for international trade[5] came to be appreciated more widely, and the International Federation of National Standardizing Associations (ISA) was formed, including among its members the national standardizing bodies of 22 countries. This organization consisted largely of American and European members, and under the conditions of World War II its operations were suspended.

In the fall of 1946 representatives of the standards associations of 25 countries met in London to set up a new international standards organization to be known as the International Organization for Standardization (ISO). Represented at the conference were: 19 European countries; the United States, Canada, and Mexico; Brazil; China and India; South Africa; and Australia and New Zealand. Howard Coonley, of ASA, is to be the first president of the International Organization for Standardization, and its headquarters will be in Geneva.

The suggestion has been made that the International Electrotechnical Commission may handle the electrical engineering sector of the ISO work, but the relationship between ISO and IEC still has to be worked out. While the general plan is that ASA and the other national standardizing bodies will form suitable channels for international co-operation, the relationships in specific fields, such as that of AIEE and other national engineering societies, is one of a number of things that remains to be clarified in the procedures of the new ISO.

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Short-Circuit Standards for Transformers

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MEMBER AIEE

System faults impose a great variety of short circuits on the windings of 3-winding transformers. Unfortunately, the present American Standard (C57) on short circuits is inadequate and subject to misinterpretation, particularly in the case of line-to-ground faults on Y-connected windings of transformers provided with delta-connected stabilizing windings.

TRANSFORMER short-circuit currents resulting from external system faults present a problem for further standardization. For an external fault the magnitude of symmetrical short-circuit currents in all windings of a transformer on the faulted system can be calculated readily, provided the impedances of the system and the impedances between all windings of the transformer are known. For unbalanced faults such calculations are facilitated greatly by the well-known method of symmetrical components, with both the transformer and the system replaced by their equivalent circuits. Information on short-circuit currents given by this process is somewhat oversimplified as a result of the implicit assumption that the vector sum of the ampere turns in all windings of a transformer remains equal to zero during the short-circuit transient. Actually, the transient is quite complex and it would be impractical to make allowance for complications in a routine calculation.

A study of short-circuit currents in windings of representative transformers as a result of faults on representative systems leads to the following conclusions:

1. Under the most unfavorable conditions short-circuit currents in transformer windings resulting from unbalanced system faults are substantially equal to short-circuit currents caused by balanced 3-phase faults. Thus, in an investigation conducted on the pessimistic basis of fully maintained line voltages and no external impedances whatever, there is no need of calculating any unbalanced faults, and complete information will be obtained from the much simpler calculation of balanced 3-phase faults only.

2. Many autotransformers, and some 3-winding transformers, particularly those in which one winding is smaller than either of the others, if calculated on the basis of fully maintained system voltages, will be found to have short-circuit currents in some winding in excess of the accepted permissible limit of 25 times

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Essential substance of paper 47-105, "Short-Circuit Requirements for Transformers," presented at the AIEE North Eastern District meeting, Worcester, Mass., April 23–25, 1947, and scheduled for publication in AIEE *TRANSACTIONS*, volume 66, 1947.

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normal load current, which is based on the usual interpretation of the present ASA rules (*C57 American Standards for Transformers, Regulators, and Reactors*). The continued successful operation of these units suggests either the presence of sufficient system impedances, or large design safety margins, or both. It would appear, therefore, that only in exceptional cases could there be any justification for specifying designs with the short-circuit requirements for any winding in excess of 25 times normal load current of that winding.

3. Under representative conditions, unbalanced system faults result in considerably lower short-circuit currents in transformer windings than balanced 3-phase faults. This justifies the well-established practice of making the delta-connected stabilizing windings of Y–Y-connected transformers and autotransformers of smaller size than the main windings as the stabilizing windings carry short-circuit currents only during line-to-ground faults and do not participate in balanced 3-phase short circuits on the lines of the main windings.

WITHSTANDING SHORT CIRCUITS

The danger of short-circuit currents is in their thermal and mechanical effects, both of which are proportional to the square of the magnitude of the currents, but in other respects follow different laws and depend on different design factors.

Disregarding such secondary factors as eddy losses, absorption of heat by the surrounding insulation, and slight variations in initial temperature, the final temperature reached by the copper depends only on the current density during the short circuit and on its duration.

Mechanical stresses imposed on a winding by short-circuit currents have their maximum value during the first cycle of the current and diminish as the displacement of the current with respect to zero decreases with time; their magnitude for any winding depends on short-circuit currents in all windings of the transformer.

The magnitude, distribution, and direction of mechanical stresses in the windings carrying short-circuit currents depend on the shape, arrangement, and configuration of windings, so that the same value of short-circuit ampere turns may result in entirely different forces if the windings are of different type or of different proportions. The ability to withstand these stresses is determined by the structural characteristics of the windings, which must be known in great detail, inasmuch as a local deformation or distortion may be as fatal to the transformer as a displacement of a complete winding.

CONTINUOUS AND SHORT-CIRCUIT RATINGS

It is perhaps natural to think that in a 3-winding transformer with windings of different continuous kilovolt-ampere capacity, the maximum short-circuit kilovolt-amperes that each of the three windings is capable of withstanding would be approximately proportional to its rating. Broadly, on the basis of "everything else being equal," that is not far from the truth.

There is, of course, no *definite* relation between the continuous kilovolt-ampere rating of windings, which depend on their ability to dissipate heat, and what might be called the short-circuit kilovolt-ampere ratings of the same windings, which depend on their ability to store heat and to withstand mechanical stresses. Such a definite relation could exist only on the basis of "everything else being equal" which is seldom the case with modern transformers.

In view of this, the practice of specifying the desired ability of a winding to withstand short circuit by giving it a fictitious, or real, continuous kilovolt-ampere rating should be abandoned, and the short-circuit rating should be specified directly as so many kilovolt-amperes, or so many times some reference kilovolt-amperes, for so many seconds.

STABILIZING WINDINGS

Delta-connected stabilizing windings of Y–Y-connected transformers deserve attention not only because of their inherent importance, but also because they are not covered specifically by the present American Standards.

Complete self-protection against line-to-ground faults can be justified economically in exceptional cases only and, therefore, need not be the basis of a general specification. As demonstrated by the service record of many years on a great variety of systems, and as confirmed by fault current calculations for representative cases, the usual 35 per cent capacity stabilizing winding is adequate for most applications. The American Standards should legitimize and clarify this well-established design practice. The required rules should specify, however, the minimum permissible short-circuit kilovolt-ampere rating of stabilizing windings and not their continuous kilovolt-ampere rating as, first, a continuous kilovolt-ampere rating is not a reliable measure of the ability to withstand short-circuit currents, and second, there can be no justification for designing a winding for continuous loading when such loading is either impossible or not required.

For autotransformers the practice has been to provide stabilizing windings equal to at least 35 per cent of the equivalent size of the autotransformer windings. As for transformers, the ASA rules should give this minimum size in short-circuit kilovolt-amperes and not in continuous capacity kilovolt-amperes. As the equivalent size of an autotransformer is always smaller than its output rating, the minimum short-circuit rating of stabilizing windings in autotransformers will be smaller than in transformers of the same output rating.

Obviously, all the standards can do is to indicate the minimum short-circuit rating for stabilizing windings consistent with good design practice. They cannot attempt to specify the short-circuit rating actually required in a given case. This decision must be left to application engineering.

While it is true that in autotransformers the per cent reactances between the stabilizing windings and the Y-connected windings, based on the output kilovolt-amperes of the unit, are usually much higher than in transformers, the resultant reduction in fault currents in many cases may be insufficient to justify the reduction in the minimum size of stabilizing windings indicated by the present practice. Because of this, short-circuit ratings of the stabilizing windings of autotransformers should be given special attention.

PRESENT ASA RULES

The present ASA rules are clear when applied for balanced 3-phase short circuits on 2-winding transformers. They are subject to misinterpretation and may be actually misleading when applied for 3-winding units, and particularly for unbalanced faults on units with stabilizing windings when these windings have no definite continuous kilovolt rating.

The very title of the rules, "Permissible Duration of Short Circuit," suggests that they are based primarily, if not exclusively, on thermal considerations, an attitude that may have had some justification at the time when the rules first were formulated because of relatively high current densities then in use.

If the reader stops at the end of the first paragraph of the rules, just before the tabulation, and ignores for the time being the reference to the time periods, he gets the impression that a stabilizing winding, being a part of a transformer, must be capable of withstanding any kind of a fault at the terminals of Y-connected windings, with maintained voltage "on all windings intended for connection to external sources of power." But the framers of the rules meant something else, as indicated by the tabulation following the first paragraph. The important point for present purposes is that, apparently, when the impedance is less than four per cent, the windings of a 2-winding transformer are not required to withstand more than 25 times rated current. What justification is there, then, to expect the stabilizing winding to be capable of withstanding more than 25 times its rated current?

The term "rated current" itself is not very clear. What is to be taken as rated current for transformers with various increased kilovolt-ampere ratings, by means of supplemental methods of cooling? What should be taken as rated current of a stabilizing winding without a continuous kilovolt-ampere rating?

Line-to-ground faults and stabilizing windings are ignored completely, as the stabilizing winding during a line-to-ground fault cannot be identified either as an excited or as a short-circuited winding in the ordinary meaning of these terms. The assumption the rules make that the maximum possible current in a winding necessarily will flow when this winding is short-circuited and the other windings are excited is incorrect.

The rules, as written, are concerned only with the duration of the fault and do not cover specifically the instance when the current in some windings during some conditions of short circuit is larger than 25 times normal.

In the concluding paragraph one wonders why "the cumulative detrimental effects of successive severe short circuits" are worse for autotransformers than they are for transformers, and why the recommendation on the use of current limiting reactors—assuming that such recommendations belong in ASA Standards—should be limited to autotransformers if the Standards do not require the windings of transformers to be capable of withstanding more than 25 times rated current.

RECOMMENDED REVISION

The intention of the revision being suggested is not to alter the spirit of the present rules, but only to clarify them and thus reduce the possibility of misinterpretation when the rules are applied to multiwinding transformers and autotransformers, and for unbalanced, as well as balanced, short circuits. The following revision is suggested:

1. Transformers shall be capable of withstanding, without injury, short circuits on any external terminals with rated line voltages maintained on all terminals intended for connection to external sources of power, provided

(*a*). The magnitude of the symmetrical current in any winding of the transformer resulting from the external short circuit does not exceed 25 times the base current of the winding (see 2 and 3).

(*b*). The duration of the short circuit is limited to the following time periods:

Symmetrical Current in Any Winding	**Time Period in Seconds**
25 times base current	2
20 times base current	3
16.6 times base current	4
14.3 or less times base current	5

Intermediate values may be determined by interpolation. The initial current is assumed to be completely displaced from zero.

2. The base current for any winding is equal to its rated current, except as noted in 3.

For self-cooled transformers with increased kilovolt-ampere ratings obtained by supplementary cooling means the base current shall be taken at the self-cooled rating.

3. In the following special cases the base current for the winding specified may be larger than its rated current:

(*a*). For multiwinding transformers the base current for any winding provided with external terminals, and for a delta-connected stabilizing winding without external terminals, shall not be taken at less than 35 per cent of the kilovolt-ampere rating of the largest winding of the transformer.

(*b*). For Y–Y-connected autotransformers:

1. The base current for a delta-connected stabilizing winding, with or without external terminals, shall not be taken at less than 35 per cent of the equivalent transformer kilovolt-amperes of the autotransformer windings which is equal to 1/2 (total kilovolt-amperes of series winding plus total kilovolt-amperes of the common winding), where total kilovolt-amperes of each winding is given by the product of the maximum voltage times the maximum current of the winding.

2. The base current for the common winding shall be equal to the maximum current in the common winding when carrying any simultaneous loads authorized by the nameplate.

3. The base current for the series winding shall not be taken at less than 35 per cent of the kilovolt-ampere capacity of the common winding or of the delta-connected winding, whichever one is the larger.

4. The combined impedance of transformers and directly connected apparatus shall be considered as limiting the short-circuit current of transformers which are connected in series with other apparatus possessing inherent impedance, located only a few feet from the transformers, and so connected to them that there will be no practical possibility of the loss of this additional series impedance.

Electrometallurgy in Canada

J. L. BALLENY
MEMBER AIEE

HYDROELECTRIC developments in Canada have provided an abundance of low-cost electric power, which has encouraged the use of electricity for metallurgical operations, particularly those in which large amounts of power are consumed. Other types of fuel are being replaced by electric heat where economy of operation is a major factor.

STEEL STRIP ANNEALING

In the manufacture of tin plate and black plate, coils of steel strip are passed through a cold reduction mill in which the thickness is reduced. Resultant severe cold working sets up very high stresses in the strip and modification of the metal structure by annealing is necessary before further satisfactory processing can be accomplished. This annealing can be performed by heating the strip in excess of 1,200 degrees Fahrenheit.

Many metallurgical manufacturers in Canada have taken advantage of the tremendous hydroelectric developments there which provide an abundance of low-cost electric power. Fuel combustion heat is being replaced by electric heat for such processes as annealing and wire patenting, and more electric power is being used in induction heating for forging and hardening, regulation of smelting furnaces, and in electric arc furnaces. Electric heat has allowed short time cycles, automatic operation, and has provided uniform results consistently.

Common practice has been to anneal such strip in coils in batch-type furnaces, but at the plant of Dominion Foundries and Steel, Ltd., Hamilton, Ontario, a continuous-strip annealing furnace has been installed which for some applications produces a superior product and which, in addition, enables much quicker handling of special or emergency orders. Figure 1 shows this furnace which is best described as a tower type and is the only one of its kind in Canada. Speed of the strip through the furnace may be varied by Ward Leonard control of the master pinch rolls at the exit end. For simplification of furnace operation temperature controls are set at a given value and the speed is the only variable which is regulated to give the metallurgical results desired. Heating units in four vertical chambers are controlled in 11 separate zones by "on-off" contactor operation, actuated by temperature control instruments. The total connected heating load is 1,680 kw. To prevent oxidation or discoloration of the sheet through oxidation, the furnace chambers are provided with a partially combusted gas atmosphere. Total power and heating consumption on typical runs has averaged as low as 157 kilowatt-hours per ton annealed.

WIRE PATENTING

Medium- or high-carbon steel wire, following drawing operations, is usually "patented" to give the proper microstructure to enable further drawing or to make it satisfactory for general use. This process requires the the wire to be heated uniformly to a temperature of 1,550 degrees Fahrenheit, followed by a lead quench or an air-cool.

At one plant of the Steel Company of Canada, Ltd., in Hamilton, Ontario, there is installed a continuous wire-patenting equipment. Heat is generated in the wires by passing through them a heavy current at low voltage. The temperature reached by the wires before being quenched is determined by the voltage applied, the distance between contact points, and the wire speed. This equipment is built to handle 16 lines of wire in parallel, with a production capacity of 3,000 pounds of wire treated per hour. Power for heating is fed to the wires through a contact bath at the ingoing end, and through a lead quench bath at the other end. The contact bath is maintained at a temperature of 1,000 degrees Fahrenheit by 129 kw of immersion-type heating elements and is supported on a movable structure to regulate the current flow. While traveling between the two lead baths, the wires become progressively hotter until the moment they dip into the quench bath.

The temperature of the lead quench bath is maintained between 700 and 1,100 degrees Fahrenheit, depending upon the properties desired in the finished wire. This quench bath is equipped with 291 kw of immersion heaters to maintain its temperature, and also has a series of cooling tubes at the incoming end of the bath to carry away excess heat given up by the hot wires. Both heaters and the cooling tubes are automatically controlled.

Essential substance of paper 47-138 "Electric Furnace Practice in Canada," presented at the AIEE summer general meeting, Montreal, Quebec, Canada, June 9-13, 1947, and scheduled for publication in AIEE *TRANSACTIONS*, volume 66, 1947.

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The power supply for heating the wires is controlled, within plus or minus one-half volt, through an induction voltage regulator actuated by a controlling voltmeter. The proper voltage to give required wire temperature must be determined from optical pyrometer readings which are tabulated for different wire sizes and speeds. Such voltages are of the order of 40–80 volts with transformer coils in parallel and 80–150 volts with coils in series. Currents vary from 7,500 down to 2,270 amperes on different taps. This method of resistance heating further assures a uniformly heated product so that duplication of results is simplified.

Figure 1. **Continuous steel strip annealing furnace rated 1,680 kw, installed at Dominion Foundries and Steel, Ltd., Hamilton, Ontario, Canada**

View of furnace from outgoing end

ALUMINUM HEAT-TREATMENT

Installations of electric furnaces in the aluminum industry in Canada exceed 30,000 kw and various types of electric resistance furnaces are utilized in melting, holding, preheating, and heat-treating of aluminum and its alloys. A typical furnace used for heat treating aluminum alloy sheets is a vertical-draft air heat-treating furnace which is box-shaped, post-supported over a quench tank, and equipped with drying chambers, a trolley system for handling load, and a horizontal door in the bottom, and which can accommodate sheets 28 feet long by 6 feet wide. The load is raised into the furnace, heated to the desired temperature, and held at this temperature until assured of equalization, then fast-quenched in the water tank below the furnace. Following this, it is moved into the drying chamber for removal of water.

The electrical capacity is 760 kw, divided into four control zones. Heating elements are mounted on the inside walls of the furnace, with steel baffles in front of them for guidance of convected air. Heat is transferred from elements to the load by means of six axial-flow fans located in the roof of the furnace, which provide the high-speed air circulation necessary. This equipment has a capacity of 50,000 pounds of aluminum-alloy sheets per 24-hour day, heating to a maximum temperature of 1,020 degrees Fahrenheit. Control is by potentiometer-type controllers actuated from thermocouples located in the air stream.

White malleable iron, as cast in the foundry, is extremely hard and brittle, and is not suitable for commercial applications until its physical properties have been changed by annealing which imparts to the metal strength, ductility, and the ability to withstand considerable distortion. Three distinct stages in annealing are: preheat, soaking at temperature. and cooling. In

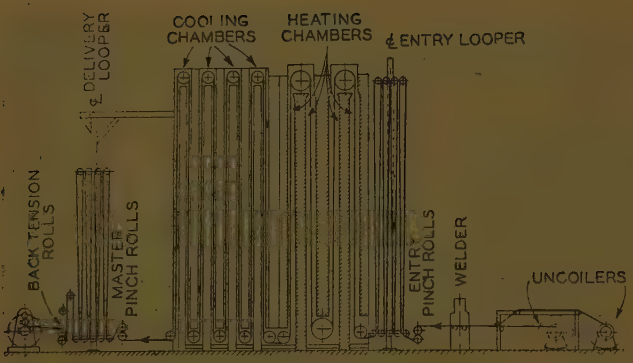


Figure 2. Schematic layout of continuous strip annealing furnace indicating path of strip through furnace

the preheat stage the castings are brought up to a temperature in excess of 1,750 degrees Fahrenheit. During the soaking period they are held at this temperature for a sufficient time to alter partially the structure of the metal. Slow cooling through the critical range further alters the structure of the metal.

Prior to the adoption of electrometallurgy in the heat-treating of malleable iron, the process was carried out in fuel-fired ovens, which resulted in a prolonged annealing cycle requiring five days or more, whereas now with electric annealing equipment it may be accomplished in 32 hours or less depending on material composition.

Continuous-type electric furnaces are in general use for this application. Castings are loaded on trays, which are pushed progressively through the heating chamber, fast cooling section, and slow cooling section to the exit end. The respective lengths of these various furnace sections are designed to suit the cycle required. In jobbing plants which are required to produce different metal analyses for different applications, a more flexible furnace arrangement is desirable, so that heating and cooling cycles may be varied. With the type of annealing cycle described, this can be accomplished by utilizing two furnace chambers and transferring the loads quickly during the fast cooling stage. The power consumption for a typical load averages 275 kilowatt-hours per ton.

INDUCTION HEATING

The development of detachable drill bits has revolutionized the mining industry and millions of them per month must be forged and heat-treated. Thompson Products, Ltd., St. Catherines, Ontario, have found that a 9,600-cycle induction heater can be utilized for both forging and hardening the bits. For hardening as illustrated in Figure 2, bits are loaded into one end of a quartz tube through which they are pushed by a reciprocating arm. The heating coil is of multiturn construction wrapped closely around 18 inches of the quartz tube. The next 22 inches of the tube is used for soaking the bits and they emerge at a uniform tem-

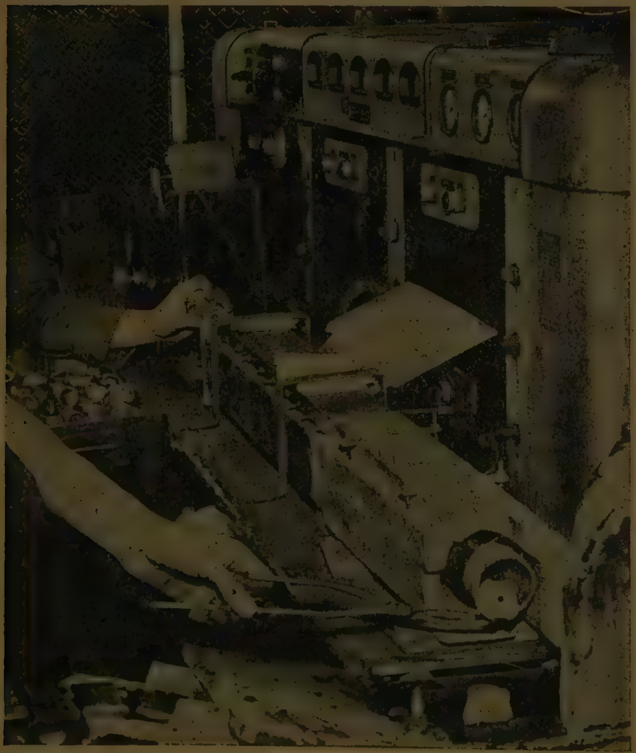


Figure 3. Motor-generator-type 9,600-cycle 125-kw induction heater for heating drill bits prior to hardening

Figure 4. Motor-generator-type 9,600-cycle 125-kw induction heater for heating drill bit slugs prior to forging

perature of 1,500 degrees Fahrenheit. Bits are removed individually from the tube by an operator and stood upright on a conveyer passing through a water bath with the cutting face immersed to a depth of only one-quarter inch, to control the hardness pattern. When putting bits through this heater at the rate of 20 per minute, each weighing from four to five ounces, the power required is 40 kw.

Because the hardening operation on these drill bits is the last operation performed on them, the equipment can be located at the end of the production line. The forging process, however, is accomplished in the early stages of manufacture in a part of the plant where smoke, heat, and dirt are usually prevalent. This type of induction heating equipment permits the location of the work station where desired and leaves the motor generator equipment in a dust-free location. Power connection to the work station is made through special noninductive cables run through copper sheathed ducts to minimize losses.

The operation illustrated in Figure 3 is similar to that of heating prior to hardening. The slugs are fed intermittently through a tube and individually removed for transfer to the forging press. Since these slugs are of uniform cross-section, they do not require additional time for temperature equalization but heat up uniformly in a tube 14 inches long which is surrounded by a multiturn coil. With a production of 11 slugs per minute, the power demand is 30 kw.

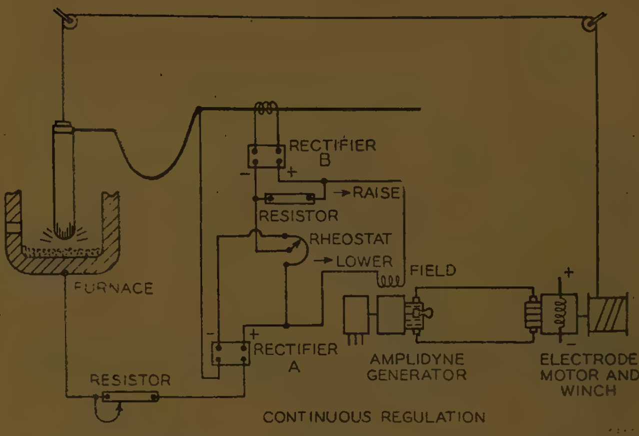
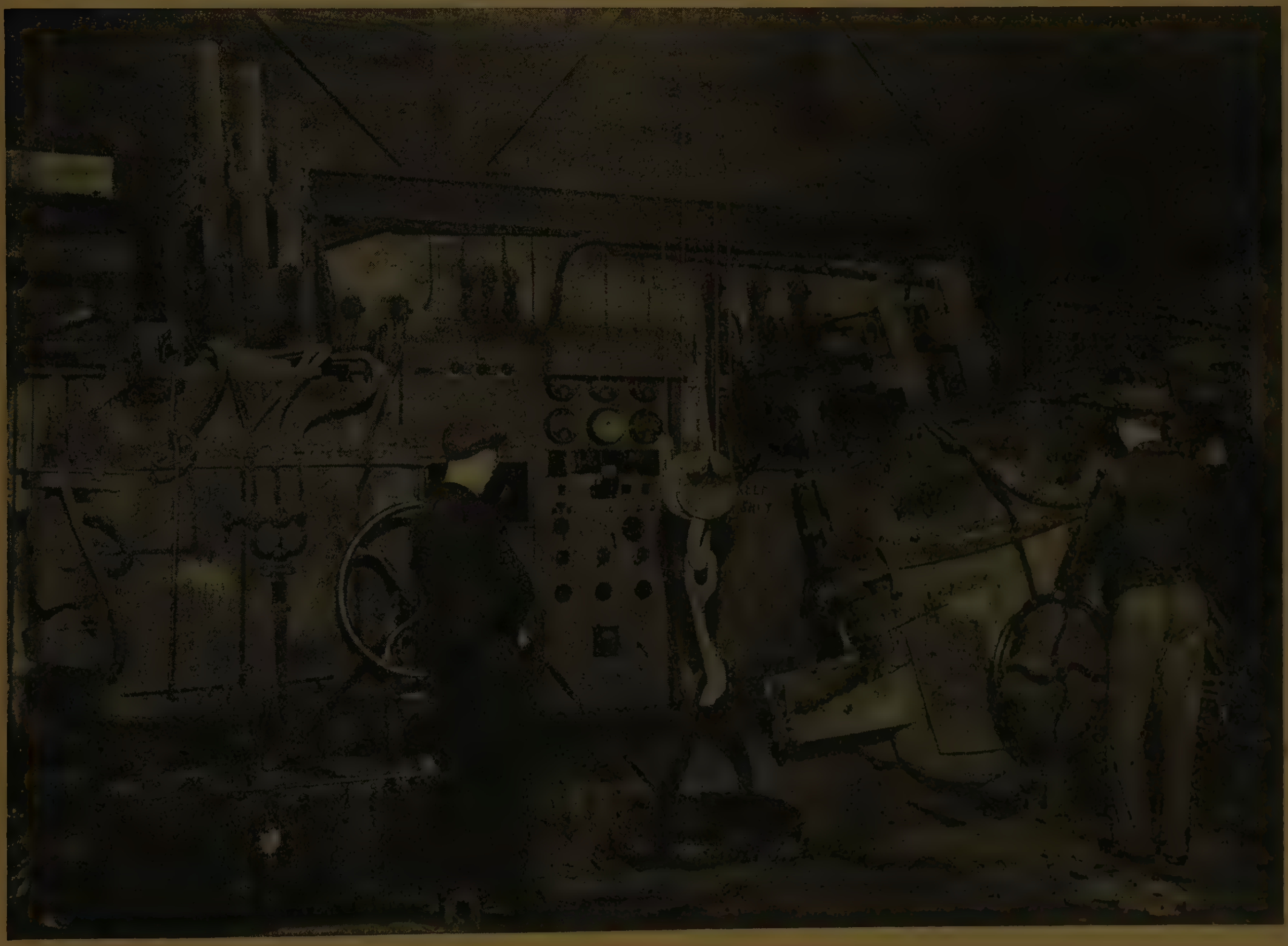


Figure 5. **Simplified circuit diagram of automatic electrode regulator**

Figure 6. **Three-phase electric-arc melting furnaces**



REGULATION OF MELTING FURNACES

Electric arc melting furnaces are in general use throughout industry today and development work has been concentrated on improving their stability and reducing power surges. At the Ford Motor Company plant in Windsor, Ontario, an amplidyne control has been applied to one of their melting furnaces which has been shown to give smooth performance under optimum operating conditions.

For best operation of an arc furnace, the regulator must utilize both arc voltage and arc current to control the electrode movement, which in turn varies the power input. Contact-making regulators have been built which operate on this combined principle, but the amplidyne method accomplishes the same functions in a smoother manner without utilizing any circuit-breaking devices. Figure 4 shows how this type of control is applied to the furnace circuit. The output of the arc current transformer is rectified and passed through a resistor. The voltage across this resistor is then proportional to arc current. The reference voltage to balance against this current-produced voltage is set up from a rectifier across the arc voltage, which is reasonably constant during normal operation. The net voltage unbalance between the two is applied to the amplidyne field, and the amplidyne output is applied to the electrode motor. High sensitivity results from the fact that a small voltage unbalance is arranged to excite the amplidyne to give full electrode motor torque. Any slight change in arc current thus promptly moves the electrodes, the amount of motion usually being small with overshooting practically eliminated.

Some of the advantages which have been reported with amplidyne control are: no hunting of electrodes, smoother power curve, lower maintenance, and less electrode consumption. Better quality low-carbon alloy steel has been produced because the reduction in electrode wastage has minimized the carbon addition to the charge.

ALLOY STEEL MELTING

A typical installation of electric arc melting furnaces, utilized in the manufacture of alloy steels, is shown in Figure 5. These two furnaces are installed in the plant of Fahralloy Canada, Ltd., Orillia, Ontario, one being rated 500 pounds per hour and the larger one 1,500 pounds per hour.

Monthly records of operation show that the average energy consumption when melting alloys is in excess of 650 kilowatt-hours per ton. During the early stages of melting, before a steady arc is established, the demand fluctuates widely. However, when the melting process has steadied down, the demand stabilizes at approximately 350 kilovolt-amperes for the 500-pound furnace and 750-kilovolt-amperes for the larger furnace.

As new metallurgical processes develop, there is an ever-increasing tendency to consider electric power as the sole source for heating whether in the form of resistance, induction, or salt-bath furnaces—since it has been shown that time cycles may be shortened, automatic operation more readily applied, and more uniform results consistently secured.

Electrically Conducting Rubber

For years it has been common practice in the rubber industry to add carbon black to rubber in order to improve mechanical properties such as increasing the wear resistance and strength. The United States Rubber Company now is utilizing the properties of carbon as an electric conductor in making a rubber product designed to carry current.

By adding enough carbon black, the normal resistivity of the rubber is reduced to a point where the rubber becomes a conductor. It still has considerable resistance but is no longer an insulator. This material promises to have important uses. Two such uses are reported in the June 1947 issue of *Electrical Manufacturing*.

One of these is in a phonograph pickup, recently introduced by the Admiral Corporation for its line of radio phonographs. The mechanical vibration of the needle as it moves through the record grooves is transmitted to the rubber element and acts to contract or expand it. This contraction and expansion causes a change in the electrical resistance of the element, and this change is translated into an electrical impulse bearing intensity and frequency to match the volume and tonal pitch of the recorded sound. The electrical impulses are transmitted and amplified through conventional amplifier circuits. Frequency response is said to be flat over a range of 10,000 to 50 cycles per second within three decibels. Accelerated life tests indicate a minimum of two years service.

The other use described is that of providing heat for homes. By making the conductive rubber into sheets and applying the sheets to the ceilings of a house, it has been found that enough electric energy can be put through the rubber resistors and radiated as heat to maintain a house at comfortable temperature levels all winter under favorable conditions. The limiting factor in such an application is the temperature of the rubber, which, for long life, should not be over 120 degrees Fahrenheit. In a test installation in a house in Knoxville, Tenn., this limitation permitted an output of about 20 watts per square foot from the conducting rubber sheet. The electrified ceilings heat 6,384 cubic feet of space. There are 588 square feet of conductive rubber in the ceiling in panels measuring 2 by 4 feet and 4 by 4 feet. The heating system has an installed capacity of 11,160 watts at 220 volts.

An A-C Vehicle Generating System

ALBERT D. GILCHRIST
ASSOCIATE AIEE

Wide speed-range operation is essential for vehicular generating systems, and only d-c machines have been practical to date. An alternator-rectifier system with high output and efficiency comparable with the d-c system is presented.

RECENT development and popular use of mobile 2-way radio equipment has demanded specialized wide speed-range high-output electric power systems. The war period demanded work on all types of wide speed-range d-c generating systems for automotive, marine, and aircraft applications, and during this time a rectified a-c system was developed. A comparison between a police car type d-c generating circuit and a rectified a-c system is presented.

D-C GENERATOR LIMITATIONS

Wide speed-range operation is a prerequisite for generators used on variable speed engines. Mechanical limitations arise in securing the windings of the armature, design of the commutator, and selection of the bearings, and cooling presents a problem with slow-speed machines. Commutation is the main speed limiting characteristic. Reactance voltage varies directly with speed, load current, number of poles, number of commutator bars, and with the square of the turns per armature coil. Thus, generators for low-speed performance with high number of turns per coil in the armature windings give short brush life at high speeds.

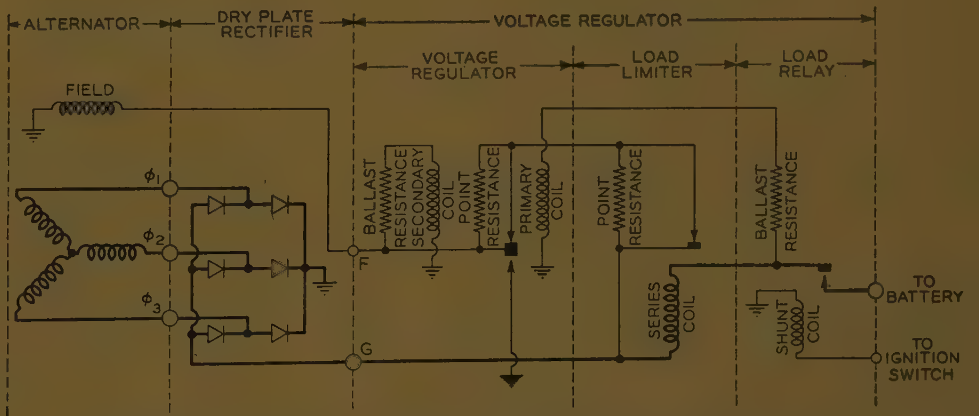


Figure 1. Rectified a-c vehicular generating system schematic diagram

A-C SYSTEM

The rectified a-c generating system comprises alternator, rectifier, and regulator circuit (Figure 1). Alternating current is generated by a 3-phase Y-connected 12-pole alternator (Figure 2), the slip rings of which are outside the bearing and isolated in a chamber which protects them from contamination thereby making the generator practically explosionproof. The rotor (Figure 3) consists of two similar 6-legged forgings making parallel magnetic paths excited by a single coil. Simple assembly and strong construction make the rotors suitable for high-speed application. The 1-turn machine-formed coils of the stator can be delta-connected. However, the Y-connected circuit is used for lower speed performance.

A voltage regulator, current limiter, and load relay comprise the system's control unit. Response to the d-c output from the 3-phase full-wave bridge-type magnesium–copper-sulphide rectifier effects control by varying the alternator rotor current. The load relay is energized through the ignition switch and protects the battery from being discharged by the small rectifier leakage current. In operation the control unit (Figure 1) voltage regulator element primary coil establishes flux to offset mechanical spring tension, and a secondary coil maintains the armature vibrating at a high frequency. A low point-resistance shunts the first set of operating contacts over a fair portion of the speed and load range of the generator.

When a resistance greater than this value is required to control the system, the regulator armature stops vibrating on the first contact and transfers to the second grounded contact, thereby collapsing the alternator rotor field to the value needed to maintain the correct rectifier output voltage. The current limiter coil in series with the load circuit establishes flux which offsets spring tension controlling its armature. Overloads cause the armature to vibrate introducing resistance in

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Essential substance of a paper, "Modern Vehicle Generating Systems," presented at the AIEE Cleveland Section prize paper meeting, January 10, 1947.

Albert D. Gilchrist is chief engineer, The Leece-Neville Company, Cleveland, Ohio.

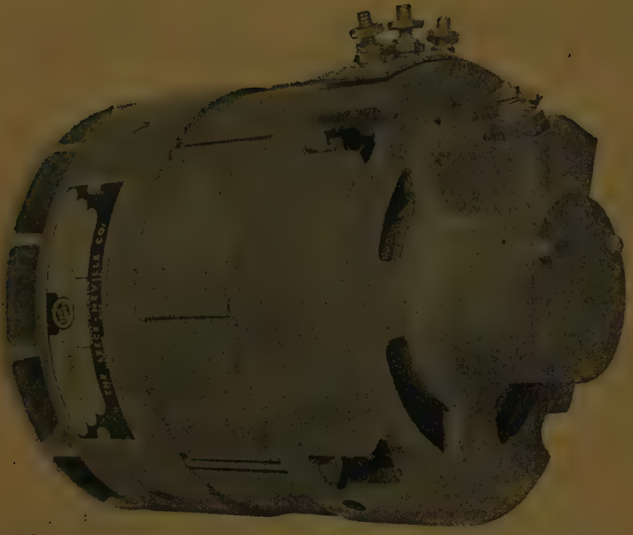

Figure 2. Vehicular 3-phase Y-connected 12-pole 7-volt 60-ampere alternator

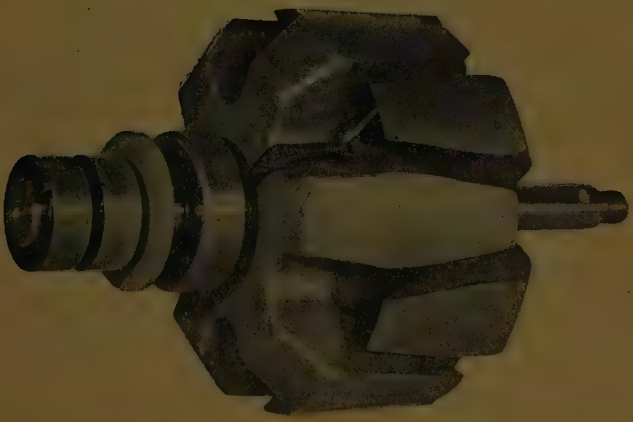

Figure 3. Alternator rotor consisting of two 6-legged forgings

the rotor field circuit to limit output current to a safe maximum value.

PERFORMANCE

The alternator-rectifier system develops rated output of 60 amperes at a much lower speed than the d-c system. Grease lubrication has not been satisfactory for continuous operation above speeds of 10,000 rpm, thus the bearings limit the maximum alternator speed to 12,000 rpm which is normally a transient operation. The alternator frequency ranges from 70 to 1,200 cycles per second, although the rectifier may be operated up to 3,000 cycles per second. Efficiency characteristics for the magnesium-copper sulphide rectifier are lower than for more expensive rectifiers, and over-all efficiency for the alternator-rectifier, a maximum at slightly under 50 per cent, is slightly lower than for a d-c generator.

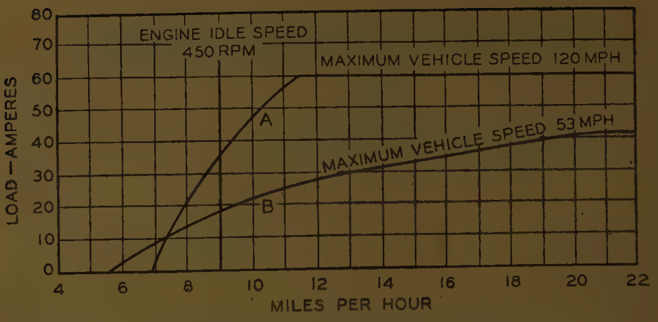

Figure 4. Comparison of d-c generator and alternator-rectifier system performance

Figure 4 compares the performance of a d-c generator and an alternator-rectifier system. The d-c system has a slightly lower cut-in speed, but the alternator-rectifier system shows a greater output over a much wider speed range. At engine idle speed the new system has approximately double the output of the d-c system.

CONCLUSIONS

The higher efficiency of the alternator makes it possible to design machines with greater output for lower speeds than d-c generators operating with the same temperature rise. The a-c generator provides a convenient source of power for heating and lighting loads. It places at the automotive engineer's disposal any value of alternating voltage he desires. An alternator may be used for a greater number of applications because it can run in either rotation or use a delta connection to gain output currents of 1.732 times the present values. Performance of the delta circuit has higher minimum speed characteristics but in many applications this is not important. The same basic alternator may be used in both 6- and 12-volt systems with only a change in rotor coil required by the voltage regulator design. Cooling of the rectifier demands attention, but this is not too difficult because practically all engines have cooling fans and the rectifier can be mounted in the carburetor intake air filter.

Ideas have been considered for the d-c generator to improve its performance and to adapt it to the more exacting requirements of present-day vehicles. Interpole design generators will increase the speed range by offsetting the change in reactance voltage with load, however, not as good results as one would expect are experienced, because the low speed of a shunt generator is increased to offset the voltage drop in the series windings and good commutation is very critical to maintain at high speeds under weak main field excitation. Constant speed drives or gear boxes are costly and difficult to lubricate. A step-up gear box and slipping clutch arrangement may be usable for low output generators, but seriously reduces the over-all efficiency when transmitting the generator torque with a wide difference between the input and the generator rpm. After reviewing these facts the alternator-rectifier system was chosen as being the best wide-speed-range high-output source of a-c and d-c power for vehicles of the future.

Military Communication Equipment Observed at Winter Tests

Task Force "Frost" operations during the months of January and February 1947 at Camp McCoy, Wis., were observed by representatives of several companies. Purpose of the task force was to service test items of equipment under heavy winter and simulated combat conditions. Observations and recommendations for improvement of the equipment tested are included.

OBSERVERS were invited to attend the winter task force test at Camp McCoy, Wis., by General Jacob Devers, commanding general of the Army Ground Forces, through R. C. Cosgrove, president of the Radio Manufacturers Association and J. Elmer Housley (F '43) president of the AIEE. Many different classes of ground force equipment were tested during the operation of Task Force "Frost" but the following comments are confined to electronic and communication equipment.

The purpose of the test was to determine suitability and operation of equipment under heavy winter conditions during simulated combat. Not only were actual operations scrutinized, but such considerations as suitability of spares, packing cases, and operator efficiency under the climatic conditions encountered were studied. Actual tests were conducted both with equipment issued and operated through normal channels, and with definite established test routines under the jurisdiction of fully qualified technicians. Several factors which appeared to mitigate the tests were the need for haste in planning, lack of familiarity with equipment by operating personnel, preponderance of mild weather, and developmental nature of some of the equipment.

TEST CONDITIONS

It must be borne in mind that operating personnel are not engineers. The majority of men who operated this equipment were trained by the Army and knew what was expected of them and the equipment which they were operating. In the field almost everything must be done outdoors or in a small tent with a very limited amount of tools, light, and heat. When equipment is in operation, the operator is in a vehicle, or tent, or in the open where he, of necessity, must wear heavy clothing and mittens. This, to an extent, limits his freedom of movement and ability to manipulate controls.

Efficiency of personnel under extreme cold conditions deteriorates rapidly. This appears to be true in spite of the excellent clothing furnished, and it is unreasonable to expect that additional precautions or maintenance are observed over that for normal conditions. On the contrary, it is probable that fewer precautions and less maintenance are executed.

With few exceptions, all of the electronic equipment used was designed for the ground force function. Some equipment which did not function properly was still classified as in the service test stage, and corrections will be made before such equipment is accepted and adopted as standard. An important factor to keep in mind is that a successful mission does not necessarily mean that equipment is not faulty and requires improvement.

CONSTRUCTION DEFICIENCIES

Among the failures observed was the loosening of a combat antenna gooseneck for set *SCR-300*. In this particular antenna the whip must be flexible to withstand striking obstructions as the operator moves through dense underbrush. Antenna mast bases *MP-65*, if improperly lubricated, becomes so stiff from internal rusting that the mast sections buckle when they strike an obstruction rather than being permitted to bend down by the base.

Cords and cables, broken at the point where the cordage enters the plug, were observed. It is believed that a type of molded cable and plug combination would reduce this difficulty considerably, although it is virtually impossible to repair one which has failed unless some small easily applied type of vulcanizing outfit is available. Relatively simple instructions concerning the operation of a vulcanizing unit should make possible field repairs of high quality with a minimum number of failures in the vulcanizing operation. A "gripe" of operating personnel is the number of interconnecting cables on equipment which must be knocked down for transportation. The number of these cables should be held to an absolute minimum as they continually are being lost or misplaced, especially in snow.

Plugs used for microphone, key, and headphone connections were observed to have been broken off because of impacts sustained while the plugs were inserted in the jacks. In addition to breakage of these plugs, difficulties were encountered due to warping of insulation. It seems improbable that this distortion of insulation is the result of cold, but it is probable that equipment was laid too close to a stove, causing softening of the insulation and consequent warping. Heat distortion accompany-

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Based on reports of M. R. Johnson, section engineer, government equipment, General Electric Company, Syracuse, N. Y.; S. W. Jucius, engineering department, radio division, Stewart Warner Company, Chicago, Ill.; and R. B. Zechiel of The Rauland Corporation, Chicago, Ill.

ing cold weather operations might be passed over easily in development of new equipment, therefore this point is emphasized.

Much of the equipment requires removal of too many small screws when equipment requires service, and maintenance personnel would like to see a simplified system of marks for standard parts as to actual value so substitutions can be made from limited supplies.

OPERATING DEFICIENCIES

Personnel of the task force reported two types of microphone failures—freezing of the transmitter and sticking of the press-to-talk button or butterfly switch. Microphones of the *T-17* type were reported to have frozen up even though protected by oiled silk covers issued as standard protection. The button on the *T-17* microphone was recommended as being convenient to operate with mittened hands. Head sets of the *HS-30* type, which have rubber ear inserts, are disliked because they are uncomfortable and they completely shut out ambient noise. Operators who had combat duty reported that they are more interested in weak ambient sounds which might indicate the approach of an enemy, than in most of the signals received on the head set. Another opinion which was prevalent concerning comfort was that insufficient attention had been given to the problem of weight distribution in carrying harness for man-packed radio equipment. It would appear that a fairly wide latitude of adjustment to accommodate variations in individuals should be provided. Reduction in size and weight required for a given degree of performance was pointed out as being one of the greatest problems to be overcome in the design of new pack sets, therefore everything that can be done to accomplish this reduction without impairing dependability should be incorporated in new designs.

Special operations such as netting, checking calibration, or correcting calibration were pointed out as being causes of misunderstanding, delays in establishing communications, or failure to maintain schedules. It was pointed out that while these operations seem so simple to the engineers who designed the sets, they are sources of trouble to inexperienced personnel who are frequently pressed into service as radiotelephone operators. To better trained operators these operations seem to be less troublesome. It is obvious that higher degrees of frequency stability, simpler calibration correction, simpler netting procedure, and widespread use of crystal control for radiotelephone operations would improve the communication problem. Frequency drift with temperature or voltage change was an observed deficiency of radio set *SCR-300*.

Net control operators reported variations as much as plus or minus eight kilocycles from net control frequencies of 2–6 megacycles. Reaction to this performance was to issue crystals for all net operation whenever possible and to abandon master oscillator operations.

Several members of the task force who had communications experience during World War II pointed out that quite frequently sets were employed to cover distances and terrain never intended by its military characteristics. Accordingly, such improperly used equipment obtained unjust criticism. This seems to have built up a criterion of acceptability based on how nearly the set approached universally useful or general purpose performance. A set was considered good only if it could "reach out" regardless of time, place, weather, or, to a great extent, distance. This opinion apparently stresses sets with wide flexibility permitting selection of frequencies suitable to almost any communications problems that arise.

It was explained that a man laboring, and breathing deeply as a consequence, finds it difficult and sometimes painful to talk during extreme cold weather operation thereby interfering with intelligible voice communication, but no opportunity was available for direct observation. This phenomenon suggests the use of some type of air preheater to warm air being drawn in by utilizing some of the waste heat of the exhaled breath, or heat from some other part of the body.

POWER SUPPLY DEFICIENCIES

Radio sets which carry a vibrator power supply built integral were criticized because they usually have no provisions for dry battery or commercial power line operation, and the sets weigh more than necessary if intended for man-packed dry battery operation. It is believed desirable to package a set without any power supply so that it has a minimum weight for dry battery operation. When wet storage battery supply is used, it is recommended that the necessary vibrators be a part of the battery package rather than part of the radio package. A-c power supplies were recommended as separate accessories for sets capable of dry battery operation. Radio set *AN/GRC-9* was recommended because of complete independence of power supply.

Operating personnel maintained that a large number of new type batteries containing mercury cells were dead when opened. Failure of this type cell is understood to be caused by the difficulty of maintaining necessary purity of materials in production, and the alleged fact that it is impossible to predict which cells will go bad until a considerable time after the cell has been built. Also it is understood that spontaneous failure of a single cell results in an open circuit which puts a series string of cells out of use.

Until such time as failure of mercury cells is brought under control, it appears that batteries having a large number of cells in a series should not be used, and mercury cells should be used for "A" supplies. If performance of mercury cells permits them to be connected in parallel without detrimental affect, "B" batteries may be constructed in which series strings consist of pairs of cells connected in parallel so that if one cell should fail the remaining cell would maintain continuity of the circuit. It also might be possible to connect across each cell a device embodying a film of high resistance but with low dielectric strength which would puncture upon application of a voltage equivalent to one-quarter of the battery's terminal voltage. Then if a cell should fail and show an open circuit, the voltage across the film would immediately rise and puncture the dielectric causing the battery to function minus one cell.

It would appear, in view of the present status of the plastics industry, that a more satisfactory material might be found for battery cases to reduce breakage, or that a resilient jacket might be made for the battery to take up most of the sharp knocks which now cause failure. It was observed also that the batteries gave short operation for charge at low temperatures.

The *TC-2* telephone central seemed much too bulky for field operation. Cord returns on this equipment are dead-weight and could be spring-loaded. The primary power source also seemed needlessly heavy and bulky.

The *AN/TPQ2* radar used at the operations was subject to failures requiring expert personnel to diagnose and remedy, and the fact that these men could not keep the equipment functioning properly would seem to indicate that the equipment still requires considerable development. While some data probably could be obtained concerning operation under winter conditions it would not constitute a conclusive service field test.

From observed and reported performance of equipment on the subject task force assignment, it is apparent that advancement of accessories has not kept pace with the technical advances in the major equipments themselves. Certain design patterns can be drawn:

1. Equipment must be designed basically for cold weather operations. The only alternative would be a winterization program instituted at a depot and run on a production basis including operational checks prior to issue.
2. Operating techniques must be simplified so that optimum performance can be obtained with minimum exertion and attention from the operator.
3. Closer co-ordination between troops using equipment and the military characteristics as established by Army boards must be established.
4. Emphasis should be placed on accessibility and ease of repair.
5. Components in general appear satisfactory, and they must be kept so as miniaturization progresses.
6. Adequate parts list and stock numbers are a necessity.
7. It continually must be remembered that troops in the field are not engineers. The ideal radio set should be as simple to operate as a dial telephone.

Recommendations concerning the conduct of such operations as Task Force "Frost" might be added. Tests should be co-ordinated with the Signal Corps laboratories and sufficient numbers of qualified technicians should accompany the task force to supervise the test and co-ordinate the data. Also the entire task force should operate in the field and not from heated quarters such as Camp McCoy offered.

The fact that radio communication is relied upon virtually to the same extent as wire communication, is the best demonstration of its acceptability and dependability. The ability of military radio equipment to withstand the severe usage of modern military services bears testimony to the vast strides that have been made in the art and to the painstaking attention to detail by all of the engineering and manufacturing personnel that have made it possible.

Figure 1. Members of Task Force "Frost" fire a 75-millimeter rifle during a night firing test

Capacitance Effect of Conductor in Magnetic Field

WALTHER RICHTER
FELLOW AIEE

The combination of a gaseous tube rectifier and a d-c motor recently has become quite popular, often with disastrous consequences for the gaseous tube. Behavior of a d-c motor is in many respects equivalent to that of a very large capacitor. An engineer aware of the severe conditions imposed on a gaseous rectifier feeding into a capacitor input filter, may connect a d-c motor to a gaseous rectifier, not realizing he may be imposing worse conditions than is the case with a capacitor.

IF A CONDUCTOR is placed in a magnetic field and a current flows through the conductor, a force will act on the conductor. If it is free to move, it will be accelerated. But when in motion, it will cut the magnetic field lines and a voltage will appear across it. If the magnetic field is uniform, further acceleration will stop and the conductor will move at a uniform speed as soon as the induced voltage is equal to the voltage impressed on the conductor from an outside source. A d-c motor with constant excitation running at no load represents such a case. If the conductor is now disconnected from the outside voltage source, it will keep in motion, due to its inertia, and therefore the voltage will continue to be induced. An ohmic resistance connected across it will take a current having a braking effect on the motion. From the viewpoint of energy, the kinetic energy of the moving conductor is being converted into heat, and the conductor finally will come to rest.

Because the passing of current through the conductor thus is seen to result in the building up of a voltage, the device acts similarly to a capacitor. The capacitor effect of a d-c armature has been recognized for a long time and has been used for power factor correction in the vibrator of Kapp, where it is connected into the slip ring circuit of an induction motor. Small d-c armatures also have been used in breaking field circuits of large generators with the armature connected across the field switch. When the switch is opened, the field current continues to flow through the armature of the small motor, which consequently accelerates and builds up a counter electromotive force until only the small no-load current of the motor is flowing which then can be interrupted easily.

With d-c armatures, even small ones, capacitance effects equal to several farads easily can be achieved. The recent developments of new materials for strong permanent magnets may dispose of the troublesome question of field supply, thus opening the way to large capacitance effects. In the following the fundamental relations between the capacitance effect and the magnetic and mechanical constants of the circuit are investigated. Examination of the formulas then will reveal whether application in a particular case may be practicable.

We start with the strict proof of the equivalence of an unrestricted conductor in a uniform magnetic field and a capacitor. For this proof no attempt is made to evaluate the numerical value of the constants, in order to illustrate the principle in question in its simplest terms.

The force acting on a conductor in a magnetic field is proportional to the current; we therefore have

$$F=c_1\times i \qquad (1)$$

Due to this force the conductor (if free to move) accelerates. If m is the mass of the conductor (including support, if any), the resulting acceleration will be

$$b=\frac{F}{m}=c_1\times\frac{i}{m} \qquad (2)$$

The velocity of the conductor at the time t is the time integral of the acceleration, or

$$v=\int b\times dt=\frac{c_1}{m}i\,dt \qquad (3)$$

But the voltage appearing across the conductor, when moving through the magnetic field with the speed v, is proportional to this speed; therefore:

$$e=c_2\times v=\frac{c_1\times c_2}{m}\int_0^t i\times dt \qquad (4)$$

It will be remembered that the voltage across a capacitor is also proportional to the time integral of the current,

$$e_c=\frac{1}{C}\times\int_0^t i\times dt \qquad (5)$$

Comparing equations 4 and 5, it is apparent that the conductor behaves exactly in the same manner as a capacitor with the capacitance

$$C=\frac{m}{c_1\times c_2}\text{ farad} \qquad (6)$$

We now proceed to evaluate the constants c_1 and c_2 of equation 6 in terms of the field strength and the length of the conductor. The calculations are made in the technical metric system, kilogram, meter, and second

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being the units for force, length, and time respectively.

As equation 1 shows, c_1 is the proportionality factor between the force on the conductor and the current passing through it. In the "Standard Handbook for Electrical Engineers," seventh edition, published by McGraw-Hill Book Company, New York, N. Y., section 2–43, we find

$$F=10.2\times i\times B\times l\times 10^{-8} \text{ kilogram} \qquad (7)$$

where

i = current in amperes
B = density in lines per square centimeter
l = length of conductor in centimeters
F = force acting on conductor in kilograms

If the length of the conductor is in meters, instead of centimeters, the force for the same current would be 100 times greater, and c_1 is therefore given by

$$c_1=10.2\times B\times l_m\times 10^{-6} \qquad (8)$$

According to equation 4, c_2 is the proportionality factor between the voltage and the speed of the conductor. In the "Standard Handbook," section 2–33, we find

$$e=B\times l\times v\times 10^{-8} \text{ volts} \qquad (9)$$

where

l is the length of the conductor in centimeters
v is the speed of the conductor in centimeters per second

If l is in meters, and v is in meters per second, the voltage will be 100 × 100 times as large, and c_2 is, therefore,

$$c_2=B\times l_m\times 10^{-4} \qquad (10)$$

In the meter-kilogram system the mass is equal to the weight of the body divided by the acceleration of gravity, that is 9.81 meter per second per second, therefore

$$m=\frac{W}{9.81} \qquad (11)$$

Putting the values of equations 8, 10, and 11 into 6, we obtain

$$C=\frac{W\times 10^{10}}{9.81\times 10.2\times B^2\times l_m^2} \qquad (12)$$

Since 9.81 × 10.2 equals 100, or 10^2, we obtain finally

$$C=\frac{W\times 10^8}{(B\times l_m)^2} \text{ farad} \qquad (13)$$

where

W = weight of the conductor and support in kilograms
B = density of lines per square centimeter
l_m = length of conductor in meters

In the following this formula is developed into a shape more convenient for the case of a d-c armature. Rotary motion is a specific case of linear motion referred to a circle with unity radius. In place of the weight we then will have to use the WR^2 (or the moment of inertia in place of the mass), in place of the actual speed v we use the angular velocity ω, and in place of the force F the torque T will have to be used. The relation between the angular speed ω and the speed in rpm is given by

$$\omega=\frac{2\pi n}{60} \qquad (14)$$

where

n is the speed in revolutions per minute

Let a d-c armature in a given field produce the voltage E when running at the speed n rpm, or at an angular speed of $2\pi n/60$. According to equation 4, c_2 is the proportionality factor between voltage and speed, or in the case of angular motion:

$$c_2=\frac{E}{\omega}=\frac{E\times 60}{2\pi n} \qquad (15)$$

In a similar way c_1 (see equation 1) for rotary motion is

$$c_1=\frac{T}{i} \qquad (16)$$

If a torque is demanded from (or delivered to) a d-c armature running at the angular speed ω, mechanical work is being performed at the rate $T\times\omega$ meter-kilogram per second. Assuming 100 per cent conversion, the armature then must take (or furnish) electric energy at the same rate as mechanical work is being performed. Since

1 meter-kilogram = 9.81 joule
1 meter-kilogram/second = 9.81 joule/second = 9.81 watt

it must be

$$9.81\times T\times\omega=E\times i \qquad (17)$$

and therefore

$$c_1=\frac{T}{i}=\frac{E}{\omega\times 9.81} \qquad (18)$$

With these values, equation 6 takes the shape

$$C=\frac{WR^2\times 9.81}{9.81\times\frac{E}{\omega}\times\frac{E}{\omega}}=\frac{WR^2\times\omega^2}{E^2}=\frac{WR^2\times 4\pi^2\times n^2}{60^2\times E^2} \qquad (19)$$

The latter formula is given by Rüdenberg, "Elektrische Schaltvorgänge," page 126, and by R. Richter, "Elektrische Maschinen," volume 1, page 519. The two authors arrive at it in a different manner. The equality of results provides a good check, however, for the correctness of the approach shown here.

If the equivalence of a d-c armature and a capacitor is once accepted, equation 19 can be arrived at in a very simple manner, by considering the kinetic energy stored in the armature as electric energy stored in the fictitious capacitor.

The kinetic energy stored in a rotating body is

$$W=\frac{I}{2}\times\omega^2 \text{ meter-kilogram} \qquad (20)$$

where I is the moment of inertia $=WR^2g$. Similarly, the electric energy in a charged capacitor is

$$W=C\times\frac{E^2}{2} \text{ watt-seconds (or joules)} \qquad (21)$$

Since 1 meter-kilogram = 9.81 joules, equating equations 20 and 21 results in (g = 9.81)

$$WR^2\times\omega^2=C\times E^2$$

or

$$C=WR^2\times\frac{\omega^2}{E^2}$$

which is the same as derived before.

In the foot-pound system, we would have

$$W=\frac{I}{2}\times\omega^2 \text{ foot-pounds}$$

$$=\frac{WR^2\times\omega^2}{32.16\times 2} \text{ foot-pounds} \qquad (22)$$

where WR^2 is now in foot²-pounds.

Since 1 foot-pound = 1.356 watt-seconds (or joules), we have

$$\frac{WR^2\times\omega^2}{32.16\times 2}\times 1.356=C\times\frac{E^2}{2}$$

Solving for C

$$C=\frac{1.356}{32.16}\times WR^2\times\frac{\omega^2}{E^2}$$

$$=0.0422\times WR^2\times\frac{4\pi^2\times n^2}{60^2\times E^2}$$

$$=0.462\times 10^{-3}\times WR^2\times\frac{n^2}{E^2} \text{ farad}$$

Controlling Electrical Hazards

CHARLES F. DALZIEL
MEMBER AIEE

This treatment of electrical hazards endeavors to rectify the condition of scanty, incomplete information or misinformation that is too common among a people experiencing greater and greater electrification of their home and industrial equipment. The behavior of electric currents and charges that makes for electrical hazards, what the accident statistics reveal, the physiological effects of electric shock and how it can be treated, all are included.

THE BIZARRE effects and the vagaries of electricity have commanded the attention of thoughtful persons for a long time. The awesomeness of natural lightning in contrast to unspectacular death from contact with low-voltage circuits has led to conflicting theories, which have confused both the scientist and the layman. Observers instinctively question why some victims suffer great physical damage from contact with high-voltage circuits survive, while others are killed instantly by seemingly casual contact with a low-voltage circuit. That the public is much more aware of electrical hazards today than ever before is doubtlessly a result of the almost daily press reports of electrocutions and costly explosions and fires attributed to electrical origin. With reference to press reports, it should be stated that a rather large number of calamities are attributed to electrical origins simply because of failure or incompetence to ascertain the true cause. However, many of these disasters are not otherwise but are truly of electrical origin.

STATIC AND DYNAMIC ELECTRICITY

Explosions and fires caused by electricity, and electrocutions, commonly are classified as originating from power circuits or from static electricity. For safety purposes, static electricity and dynamic electricity can be differentiated only by mode of generation. The usual definitions, namely that static electricity is electricity standing still, and that dynamic electricty is electricity in motion, are of little value in discussing electrical hazards. Death or damage to property can occur only when electric charges move. Transfer of electric charges, regardless of their origin, constitutes an electric current, and it is the flow of electric current that gives rise to damage.

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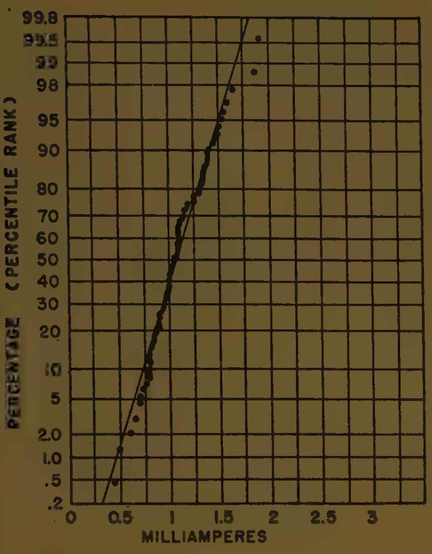

Figure 1. Experimental perception points for 114 men using 60-cycle current

Costly explosions and fires caused by static electricity occur frequently in grain elevators, oil refineries, munitions plants, paint factories, motion-picture projection booths, hospital operating rooms, textile mills, printing establishments, gas-filled basements, and when petroleum products are discharged from tank cars or trucks. Many aircraft disasters, such as crash landings, fires, and explosions in the air, are attributed to static electricity. The United States Armed Forces report that some 25 per cent of airplane casualties in the Army and Navy during the recent war, at home and abroad, resulted directly from obliteration of radio communications and from the erratic behavior of radio flight instruments by static interference. Electrocutions, explosions, and fires also are caused by insulation failures in power machinery and associated equipment, home and farm appliances, and the like.

Dynamic electricity, that is, the electric current of industry, is generated by rotating machinery or by chemical action. A-c and d-c dynamos generate electricity by virtue of the rotation of electric conductors in a magnetic field. Storage batteries and dry cells produce electricity as a result of chemical action between dissimilar substances. These means of generating electric energy are well understood and subject to precise control. The most important effects produced by electric power currents are the continuous production of heat, light, chemical action, magnetic forces, mechanical forces, and the electric arc. Danger to life and damage to property eventuate only when there is a failure of insulation, a misapplication of electric equipment, or an error due to faulty judgment, ignorance, lapse of memory, or carelessness.

By contrast, the generation and control of static electricity is not well understood for the reason that static electricity is generated by the contact and subsequent separation of particles or minute projections of insulating materials, or by the tearing apart of water droplets. Everyone is familiar with the accumulation, noticeable especially in cold dry weather, of electric charges as he scuffs a carpet, and with the consequent shock and spark when his hand approaches a grounded metal object. Usually the spark is harmless, and the shock is annoying only because it is unexpected. But in an industrial plant such sparks may be produced in a space containing combustible gases or dust, and there they constitute a very serious explosion hazard. The voltages which result from rapidly moving belts, conveyers, paper stock, fabrics, and rubber-tired vehicles, as well as those which originate at nozzles from rapidly issuing steam and gases, attain amazingly high values under favorable conditions. Electric charges also may be produced when petroleum products flow through pipes and hoses under conditions of high velocity and violent turbulence. The accumulation of these charges at terminal tanks under favorable conditions may produce voltages from a few thousand to as many as 75,000 volts. Surprising as it may seem, a person can electrify his body to as high as 10,000 volts merely by scuffing over a woolen rug, and consequent discharge may cause a spark of sufficient intensity to ignite a gas jet or discharge an electrical blasting cap. Although fortunately not of common occurrence, many serious accidents and deaths have been attributed to the ignition of vapors from anaesthetics administered to patients on the operating table, owing to the discharge of the body charges generated by the surgeons when scuffing about on the floor during the operation.

Lightning, the most terrifying of frequent natural phenomena, is the result of vast accumulations of electric charges and their sudden discharge. The static electricity generated in a thunderhead is believed to result from the sudden tearing apart of water droplets as they are caught in the violent turbulent updrafts which are always present in thunderheads. The effects produced by static electricity are mechanical forces of attraction or repulsion and the spark or lightning flash. With the exception of the tumultous phenomena associated with lightning, these effects ordinarily are unspec-

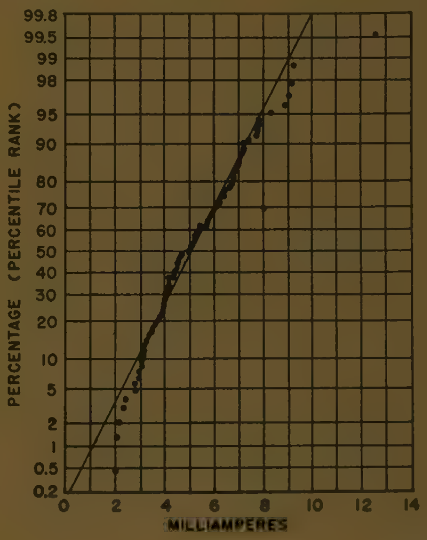

Figure 2. Experimental perception points for 115 men using direct current

Table I. Low-Voltage Accidents Taken From Newspaper Clippings—1936-37; 1940-42

	Home and Farm										Others																					
											Under 150										Over 150											
	1936		1937		1940		1941		1942		1936		1937		1940		1941		1942		1936		1937		1940		1941		1942		Totals	
	NF	F	NF	F	NF	F	NF	F	NF	F	NF	F	NF	F	NF	F	NF	F	NF	F	NF	F	NF	F	NF	F	NF	F	NF	F	NF	F
Bathtub:																																
Contacting cords	0	2	0	2	0	4	0	2	1	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	16
Contacting portable outside	0	5	0	6	1	3	0	5	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	25
Portable immersed	0	2	0	5	1	6	0	2	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	20
Extension cord:																																
Socket or plug	1	1	0	8	1	9	2	9	0	7	0	4	1	5	0	4	0	2	1	7	0	0	0	0	0	1	0	0	0	0	6	57
Cord	0	4	3	6	2	5	1	10	3	10	2	4	2	5	0	6	3	3	1	4	0	0	0	0	0	0	0	1	1	4	18	62
Floor and table lamp:																																
Frame	1	3	0	3	0	5	0	9	1	4	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	3	25
Conductor	1	0	3	2	0	4	0	1	1	3	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	10
Vacuum cleaner:																																
Frame	0	0	0	0	0	0	0	2	0	2	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	5
Conductor	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Flatiron; toasters:																																
Frame	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Conductor	0	0	1	0	0	1	1	1	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3
Washing machines:																																
Frame	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Conductor	0	0	0	1	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
Refrigerators:																																
Frame	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Conductor	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Portables (miscellaneous):																																
Frame	1	0	0	1	0	0	0	2	2	2	0	1	0	2	0	2	0	3	0	1	0	2	0	1	1	0	2	6	0	0	6	23*
Conductor	2	0	0	0	0	2	0	2	0	3	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	1	0	0	3	9
Drills, sanders, saws, and so forth:																																
Frame	0	2	0	0	0	1	1	2	0	2	0	0	1	5	6	7	2	16	2	8	1	3	0	0	0	1	0	1	0	0	13	48**
Conductor	0	0	0	0	0	1	1	1	0	0	0	0	0	1	0	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	6
Touching live current-carrying parts	2	1	7	5	4	6	4	5	5	9	4	8	6	10	1	11	3	11	3	17	2	2	1	15	3	11	1	35	0	19	46	165
Shocks from permanently wired equipment	0	1	1	1	0	0	1	4	0	1	2	2	0	1	0	1	0	3	0	1	0	0	0	0	0	0	2	2	0	2	6	19
Energized nonelectric equipment	4	0	3	6	1	1	2	2	3	5	0	2	1	1	1	1	2	3	0	1	0	0	0	1	0	1	4	1	1	1	22	26
Repairing testing electric equipment	0	2	2	6	1	2	0	8	1	2	1	0	0	0	0	5	2	2	0	2	0	1	2	2	0	7	0	6	1	12	10	57
Doing a wiring job	0	0	0	5	0	1	2	0	1	3	4	0	1	1	0	2	1	5	0	4	1	3	0	4	0	0	1	8	0	1	9	37
Welding machines	0	0	0	0	0	0	0	1	0	0	0	1	0	5	0	9	2	12	0	9	0	0	0	0	0	0	0	0	0	0	2	37
Crane, trolleys, and the like	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	6	1	0	2	10	0	9	6	26
Grasping wires outside	6	1	5	0	5	3	8	3	3	1	0	3	3	1	0	2	0	1	1	1	0	0	0	0	1	1	0	2	0	1	32	20
Working in mine	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	6	1	22	2	33	1	20	4	85
Electric fence	3	1	1	3	2	3	0	3	1	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	17
Shocks, no details or not clear	0	0	0	0	0	2	0	2	1	2	3	1	2	3	1	6	1	1	1	7	0	1	1	3	0	3	0	7	1	8	11	46
Total	21	25	27	60	19	61	23	76	24	82	16	26	18	41	10	59	17	65	10	62	5	17	6	38	7	47	14	113	5	77	220	849

NF—Nonfatal.
F—Fatal.

* Includes five cases required to be grounded by present code rules.

** Includes 31 cases required to be grounded by present code rules, two cases where grounding means were provided and not used, and four cases where intended grounding means was the direct cause of the shock.

tacular and feeble. Static electricity is important mainly because of its capricious behavior, because it may be a source of annoyance, and because it may produce fire or explosion. As atmospheric conditions change continually, static electricity is difficult to predict and difficult to investigate experimentally in the laboratory.

MITIGATION OF ELECTRICAL HAZARDS

Lightning. Although the energy in the lightning discharge is small, the rate of energy dissipation is tremendous. The resulting pulse of current and the accompanying mechanical forces may produce scarcely believable damage in the immediate vicinity of the stroke. Just prior to a lightning stroke the electric field is intense, and very large numbers of electric charges accumulate on near-by objects. At the instant the stroke occurs, the electric field between the cloud and the earth collapses, thereby releasing these bound charges, which, in turn, may produce secondary discharges. The secondary discharges are called induced strokes and, though of much less intensity than the main stroke, may break down commercial electrical insulations, or, if they result in open sparks, cause fire or explosion. Protections against lightning are lightning rods and gaps, ground wires, bonding wires, and lightning arresters.

Static Electricity. Similar to a lightning flash, except that the charges and voltages are very much smaller, is the discharge of static electricity. Control of industrial static electricity takes various forms. However, all methods depend upon neutralizing or discharging the static electricity, so that no spark is produced. Although each problem has to be solved to meet its own distinctive conditions, the fundamental method universally employed for eliminating or mitigating the hazards occasioned by static electricity is to provide means whereby the electric charges are led away harmessly as fast as they are produced.

When all the objects concerned are conducting, this can be accomplished readily by bonding all conducting objects together and connecting them to a common ground, thus preventing the formation of sparks between conducting objects; such sparks are usually far more intense and likely to start a fire than are the much feebler sparks which occur between the insulating surfaces. This procedure has a further advantage: it provides protection against electric shock to the operator of electric equipment—shock which might result from an accidental leakage or insulation failure between the energized conductors and the frame of the machine. To be effective in discharging static electricity as fast as it accumulates, only very high resistances to ground are required; resistances of millions of ohms suffice. To provide satisfactory grounding against leakage from the power circuit, however, the ground circuit must have a resistance sufficiently low to permit enough current to flow to operate the circuit protective equipment, such as fuses or circuit breakers. Heavy conductors must be used where the ground connection also may be called upon to carry currents resulting from lightning strokes. Recent developments in semiconducting rubber, linoleum, and paints should be of great value in reducing static hazards of insulating materials in industrial processes. New partially conducting floor coverings and semiconducting shoes, have reduced the static-electricity hazard of hospital operating rooms. Similarly, use of proper grounding has reduced the static hazards of tank trucks. Semiconducting belts should prove an excellent remedy for static troubles encountered by this kind of equipment. Use of static neutralizers at the place where the static electricity is generated also has met with success when due consideration has been given to their limitations. Methods employing maintenance of a relatively high humidity—high enough to permit the static electricity to discharge as surface leakage currents—have been less successful.

Dynamic Electricity. Despite years of painstaking research and scientific development which have increased greatly the safety of electric machinery, equipment, and home appliances and despite inspection of new installations which has done much to guard against misapplications, poor workmanship, or defective materials, shock and fire hazards still may develop from a variety of causes. Hazards due to insulation failure are minimized by bonding and grounding of all metal noncurrent-carrying parts, such as conduits and machine frames. It is very important that ground wires be strong mechanically, so that they will not be broken easily, and that they have a current-carrying capacity sufficient to conduct the short-circuit currents harmlessly to ground. The resistance of the ground wires and the connections to ground must be low enough to permit operation of the circuit protective equipment, such as circuit breakers and fuses. When viewed in this light, the danger of overfusing, not to mention the coppering of fuses, immediately is perceived.

After all technical precautions have been taken, the second line of defense is education. The public must be warned continually against using defective or wornout machines, equipment, and appliances. The slightest shock must be regarded as having potentialities of death; the device must be disconnected immediately and inspected competently. The public must be educated to employ extreme caution when using electric machines and appliances in hazardous locations. For example, moisture and adjacent grounded objects create serious hazards and those responsible for safety must inculcate the habit of standing on some insulating material, such as a rubber mat, a dry board, or a pile of canvas, when electric equipment is being handled in wet basements or inside metal tanks. It must become axiomatic that an electric fixture or appliance never should be touched by anyone in a bathtub. Space does not permit a more extensive discussion of the safe application of electric devices; but the foregoing examples illustrate the general solution of the problem. Fortunately, common sense will answer most questions concerning the safe use of electric appliances in the home or on the farm. Technical questions should be referred to the professional electrical engineer.

STATISTICS ON ELECTRICAL ACCIDENTS

The frequency of electrical fatalities in the United States in recent years is fairly constant at 1/100,000 of the population. This figure is only a rough estimate, as it is difficult to obtain accurate information on a nationwide basis. Even where state commissions exist to record and investigate both nonfatal and fatal accidents, they generally restrict their activities to industrial accidents.

In September 1946, the Committee on Article 250, National Electrical Code, prepared a comprehensive report on electrical accidents, with special reference to reducing electrical hazards by proper grounding. Table I, a compilation of low-voltage accidents taken from this report, is based upon newspaper clippings for the years 1936–1942 inclusive. Electrical accidents are classified according to the voltage of the circuit involved. Accidents on circuits below 600 volts are called low-voltage accidents. These are subdivided further into those under 150 volts and those over 150 volts but less than 600

Table II. High-Voltage Accidents Taken From Newspaper Clippings—1940–42

	1940		1941		1942		Totals	
	NF	F	NF	F	NF	F	NF	F
Kite strings and similar cases	9	15	7	8	1	9	17	32
Climbing poles or towers	6	8	8	12	5	25	19	45
Cranes, booms, well rigging	26	49	14	46	11	62	51	157
Long pipes, beams, flag poles, and so forth	7	12	10	23	4	13	21	48
Climbing trees and trimming	3	9	3	5	5	3	11	17
Contacting directly or indirectly wires down	15	47	7	33	12	38	34	118
On freight cars and outside trolleys	11	8	4	11	4	20	19	39
Nonelectrical workers: house movers, fence builders, and so forth	6	13	3	17	2	13	11	43
Electrical engineers, testers, electricians	4	3	4	18	1	10	9	31
Auto accidents, felling trees, and so forth	3	11	1	9	6	21	10	41
Primary crossed with secondary	0	2	0	3	0	0	0	5
Miscellaneous	5	10	4	12	3	11	12	33
Totals	95	187	65	197	54	225	214	609

NF—Nonfatal F—Fatal

volts. Especially to be noted is the substantial number of accidents which occurred in the home or on the farm, especially those involving bathtubs, extension cords, and lamps. Accidents involving portable tools are of particular interest because of the recent change in grounding recommendations. A similar tabulation of high-voltage accidents (excluding utility cases), that is, accidents on circuits of more than 600 volts, for the years 1940–1942 inclusive, is given in Table II. How many of the actual total of electric shock cases have been reported in the newspapers, it is difficult to say. A check made in one state indicated that, so far as fatal shock cases were concerned, the proportion reported in the newspapers was high. The small number of nonfatal shock accidents indicates that relatively few nonfatal electric shock accidents are reported in the newspapers. In Table III are tabulated electrical accidents reported by the California Industrial Accident Commission. It is mandatory for all industries in California to report electrical accidents, both fatal and nonfatal. This tabulation is of particular interest because it gives an accurate measure of the relative number of fatal to nonfatal shocks. By way of comparison, the National Safety Council report for 1944 gives 35,000 fatal accidents in the home, and 17,500 fatal occupational accidents, or a total of 52,500 fatal accidents within buildings. The average number of low-voltage fatal electric shock accidents per year, as reported in the newspapers, are but slightly in excess of 3/10 of one per cent of the total fatal accidents reported by the National Safety Council for 1944. This comparison is presented, not as argument that there is no need for further improvements in preventing electric shocks, but merely to emphasize that the electric wiring in buildings and equipment causes an exceedingly small proportion of the total fatal accidents in the country.

Fatal accidents reported during the year 1945 within the electric light and power industry are analyzed in the April 1947 issue of *Distribution Engineering*. Although 68 per cent of the fatalities were attributed to electric shock or burns involving circuits from 110 to 66,000 volts, only four fatalities were reported for voltages in excess of 33 kv. This may be surprising in view of the fact that circuits up to and including 220 kv are worked while energized.

CURRENT—THE DANGEROUS ELEMENT

In general the hazard from contact with high-voltage power circuits is appreciated by both the electrical worker and the public; unfortunately recognition of the danger of low-voltage shocks is not equally widespread. While it is true that the hazard from contact with electric circuits is largely dependent upon voltage, the actual danger to life depends almost entirely upon the current produced. A man accidentally coming into contact with a 60,000-volt circuit when standing on a very dry wood pole may cause a smaller current to flow than he who inadvertently grasps a defective 110-volt portable appliance when in a bathtub. Ohm's law, $I=E/R$, applies in both cases. The difference in the circuit resistance in the two cases may be sufficient to compensate for the great difference in the voltages. It is the ratio of voltage to resistance that determines the current that will flow and the danger to life. It is difficult for the layman to grasp this difference between the hazard of voltage and the danger of electric current. Current is the proper measure of electric shock intensity; damage to living tissue is caused by current and not by voltage. For a given voltage, the current that flows in a circuit depends upon the resistance of the circuit.

RESISTANCE OF THE HUMAN BODY

With the exception of special constant current circuits (such as high-reactance sign transformers and certain radio circuits), the resistance of the power circuit is usually negligible in comparison with the resistance of the body circuit; the latter includes the internal resistance of the body, skin, and contact resistance. It is believed that the resistance between major extremities, such as between the arms, leg to arm, and leg to leg, is about 500 ohms; the resistance from temple to temple about 100 ohms. The resistance of the body circuit when the skin is dry may be as high as 500,000 ohms. When the points of contact are wet with salt solutions or perspiration, this value may fall to 1,000 ohms. Furthermore, body and skin resistance decrease with both time and current. In high-voltage shocks, deep burns may be produced instantly, and the protection afforded by the skin then vanishes. In this case, the resistance of the circuit suddenly falls from its original high value to a low value of 500 ohms or less. The protection afforded by dry skin accounts for the relatively few accidents on low-voltage circuits.

SHOCK CURRENT VERSUS RATED CURRENT

It is important to note that the normal or rated current of a circuit bears no relation to the current which may

Table III. Reported Electrical Injuries in California Industries (for Fiscal Year Ending June 30, 1946)

	1942		1943		1944		1945		1946		Totals	
	NF	F	NF	F	NF	F	NF	F	NF	F	NF	F
Low-voltage accidents	346	9	497	13	401	19	281	9	220	6	1,745	56
High-voltage accidents	53	7	17	9	33	8	28	10	27	8	158	42
Accidents due to contacting high voltage lines (crane booms, mobile equipment, steel cables, and the like)	28	16	28	16	21	8	20	13	30	14	127	67
Totals	427	32	542	38	455	35	329	32	277	28	2,030	165

NF—Nonfatal F—Fatal

flow during accidental contact or during a short circuit. The danger from electric shock resides in the current passing through the body and not in the normal current consumption of the device. It has been shown that the current passed through the body in accidental contact depends upon the voltage and body, skin, and contact resistance, and the resistance of the rest of the circuit (in most cases this latter item may be neglected). As moisture and firm contact with the circuit greatly affect the total resistance, the hazard is increased many times when moisture and well-grounded objects are involved. By way of contrast, consider the automobile. At the instant a driver steps on the starting switch, the 6-volt storage battery produces currents upward of 400 amperes, but there is no electric shock hazard because of the very low voltage of the battery. By contrast, a 110-volt circuit in which no current is flowing may be extremely hazardous when hands that are wet or bleeding make contact with it. The hazard is amplified many times during contact with inherently more hazardous high-voltage circuits which also are likely to produce burns puncturing the skin resistance and thus reducing the circuit resistance to a very low value. In such instances the current developed may be sufficient to blow fuses or operate circuit breakers.

HOW ELECTRIC SHOCK CAUSES DEATH

A consideration of the effects of 60-cycle alternating current will give a general survey of the various causes of death due to electric shock. Many complicating factors are passed over lightly in the interest of simplicity and brevity. Much of the material has been taken from the references listed at the end of the article. With the exception of data taken from the works of Ferris, King, Spence, and Williams, or supplied by these investigators, the figures are results of the author's investigations conducted at the University of California.

The minimum current that just can be perceived is important, because it is essential that the user does *not* get the sensation of shock when using an electric appliance. Although no electrical hazard is produced by currents slightly in excess of the threshold of perception, such shocks are startling and can cause loss of balance and subsequent injury by a fall. Figure 1 gives experimental results obtained on 114 men holding small copper wires loosely in their hands with 60-cycle alternating current applied. The threshold of perception is taken at 1.0 milliampere, which is the response for 50 per cent of the group. Experience has shown that if the current is limited to 0.3 milliampere the chance of shock sensation is small. It is evident from the curve that 0.3 milliampere is below the threshold of perception for approximately $99^1/_2$ per cent of the group. Figure 2 gives experimental results obtained on a similar group of men when direct current was used. The threshold of perception on direct current is about 5 milliamperes, which is 5 times higher than that obtained on commercial 60-cycle alternating current.

With gradually increasing alternating currents, the first sensations of tingling give way to contractions of the muscles. Sensations of heat and muscular contractions increase as the current is increased: sensations of pain develop, and finally the current is such that a person cannot release his grasp of the conductor. At this point the victim is said to "freeze" to the circuit, and, if this is long continued, collapse, unconsciousness, and death result. Owing to the statistical nature of the response, and to the fact that abnormalities would be present in a large group of the general population, it is impossible to define an absolutely safe current for all persons. For many practical purposes the "let-go current" for $99^1/_2$ per cent of an experimental group is considered a reasonably safe current. If connections to the body are firm or wet and the shock is of short duration, currents at the "let-go" level produce no aftereffects. Burns may be produced if abnormally large current densities are present, such as those resulting from pin-point contacts and sparks. Currents in excess of one's "let-go" limit are frightening and painful. Reasonably safe "let-go currents" for 60-cycle alternating current for men and women are 9.0 and 6.0 milliamperes, respectively. The corresponding values for direct current are 62 and 41 milliamperes. Alternating currents in excess of about 25 milliamperes are very painful, and, when the current pathway is across the chest, the muscular reactions become so severe that breathing is difficult if not impossible for the duration of the shock. Death may result from asphyxiation if the current persists for more than a few minutes. However, if the current is interrupted within a reasonable time, breathing resumes automatically, and no serious aftereffects result.

Currents considerably in excess of those causing stoppage of breathing due to muscular contractions may produce temporary paralysis of the nerves controlling respiration, a condition termed respiratory inhibition. Respiratory paralysis may last for a considerable period after interruption of the current, and immediate and continued artificial respiration must be applied to prevent asphyxial death. Often, respiratory inhibition disappears in a few minutes, or in a few hours, and continued application of artificial respiration may save the victim. Mere cessation of natural breathing is not likely to produce serious aftereffects or permanent damage, as is evidenced by the many persons who have been resuscitated successfully.

Currents in excess of 100 milliamperes, if they take a pathway through the body in the region of the heart, may affect the heart, causing what is called ventricular fibrillation. Ventricular fibrillation is nearly always fatal and is commonly called instantaneous electrocution. As experimental work on human hearts is impossible, resort is made to animal experimentation. For shocks short in duration as compared with the period of the heart cycle, the probability of producing ventricular fibrillation varies with the part of the heart cycle in which the shock occurs. Results obtained on sheep during the most sensitive part of the heart cycle, and calculated results for man, are given in Figure 6 of reference 10. The greater tolerances for shocks of short duration, together with the variability in sensitivity of the heart to fibrillate, explains why some accident victims survive apparently heavy momentary shocks, such as those from capacitor discharges and high-voltage impulse generators. Although the experimental data in that figure are for sheep, and the calculated values for man were based primarily on these data because of the greater amount of data available, results of other tests made on calves, pigs, dogs, cats, rabbits, and guinea pigs also were used in order that the results might be more applicable to man. Because of various uncertainties in analyzing the data, the calculated response for one half of one per cent of all 70-kilogram animals, including man, is plotted as two curves. It is believed that values for man may fall in the space between the crosshatched lines.

Variation in the susceptibility to ventricular fibrillation with the magnitude of the current is shown in Figure 7 of reference 10. The susceptibility increases with current up to a maximum and then decreases as the current is increased. The explanation of this phenomenon is that the muscular contractions produced by these high currents cause such violent contractions of the chest and heart muscles that the heart is held still in a viselike grip, and fibrillation is prevented. If the shock is of appreciable duration, death from heart failure is inevitable; if the shock is of short duration the muscles spontaneously relax upon interruption of the current, and the heart may resume its normal rhythm. This concurs with observed accident cases, for it has been observed that the proportion of victims of high-voltage shocks who can be resuscitated increases as the circuit voltage increases. Although there is no known cure for ventricular fibrillation, it is believed that the abdominal massage and accompanying stimulation of the heart caused by the application of artificial respiration may be beneficial in assisting the heart to regain its normal rhythm. As it is impossible for the layman to distinguish between respiratory inhibition, ventricular fibrillation, and heart failure, he should begin artificial respiration immediately upon rescue of the victim from the circuit. It is very important that resuscitation be continued without interruption, because, if the supply of oxygen to the brain is cut off for more than a few minutes, serious permanent injury to the brain is likely to result should the victim recover. The victim should be kept warm and a physician brought to the scene as soon as possible. Artificial respiration should be continued until the victim recovers, or until *rigor mortis* sets in, or a physician pronounces him dead.

Table IV. Possible Results of a Brief Contact With 60-Cycle Alternating Current

Body and Contact Resistance	Circuit Voltage		
	100 Volts	1,000 Volts	10,000 Volts
Low—500–1,000 ohms	Certain death, slight burns	Probable death, marked burns	Possible survival, severe burns
5,000 ohms	Painful shock, no injury	Certain death, burns probably slight	Probable death, severe burns
High—50,000 ohms	Scarcely felt	Painful shock, no injury	Certain death, burns probably slight

Relatively large currents, amperes and *not* milliamperes, may cause death by heating of the body, hemorrhages, and serious burns. Delayed death may be caused by burns or other serious aftereffects. Death also may result from a combination of the causes just mentioned, or from complications such as injury by a fall or a broken neck.

Table IV summarizes in practical form many of the data presented in this article. It is gratifying that, in a majority of cases, victims surviving serious electrical accidents suffer no permanent disability.

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A-C Power Transmission Economics

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Comparatively few writers have dealt with the economic problem in transmitting power long distances. In this analysis important possible variations in cost were studied and considered carefully in order to test the validity of the conclusions which were drawn. The effect of these variations tempered the conclusions which are presented here.

ATTENTION now being given to longer-distance and higher-voltage transmission and the comparisons currently being made with other methods of transporting energy, make it worth while to show for assumed costs and conditions some of the important economic factors and the conclusions resulting therefrom.

The costs used in this study correspond to averages considered to be representative in 1945, and no attempt has been made to adjust them for recent changes. The higher voltage levels selected for parameters, 360 and 450 kv, are not necessarily standard voltages, as this study was made before standardization of the higher-voltage steps had been realized. This analysis is in three parts: (*A*) 200–600-mile transmission, line loading based on steady state power limits with 25 per cent margin with systems having typical terminal impedances; (*B*) 100-mile transmission, line loading based on most economic loading independent of stability; (*C*) 200-mile transmission, line loading based on transmission of 1,000,000 kw dependent on transient stability limits. Although the problem is approached in these three different ways, the results are consistent among themselves such that an over-all picture of the economics is obtained. The following assumptions and basis for analysis apply to both parts *A* and *B* of this study:

1. Cost per mile of single circuit transmission line was obtained from a curve showing cost to vary (for a resistance to reactance ratio of 0.1) from $17,000 per mile for a 110-kv line to $50,000 per mile for a 450-kv line. Only the cost for a line having a conductor resistance of 0.08 ohm per mile is used in part *A*. Other studies indicate that, at high load factors and loadings, such a conductor is in the economic range even for the lower voltages (110–230 kv).

2. Cost per kilovolt-ampere of transformers was obtained from a curve varying from approximately $3 per kilovolt-ampere for a 110-kv transmission line to $10 per kilovolt-ampere for a 450-kv line which included installation costs and corresponded approximately to a sending-end low voltage of 13.8 kv and a 3-winding transformer (primary secondary, and tertiary) as the receiving-end transformer. The high-voltage windings of the transformers are Y-connected and effectively grounded. The 450-kv transformer costs have been increased to allow for the use of transformers of 60 per cent normal leakage reactance, and the 360-kv transformer costs have been increased to allow for the of transformers with 80 per cent of normal leakage reactance. It is to be noted that whereas the cost data were obtained from a smooth curve, actual costs would tend to be higher than this curve at points intermediate between those representing standard voltage levels.

3. Installed circuit breaker position costs were obtained from a curve obtained by drawing through average representative costs at the standard and assumed standard levels varying from approximately $80,000 per station per single transmission line circuit for a 100-kv line to $1,200,000 for a 450-kv line.

4. Synchronous condensers were taken as $6 per kilovolt-ampere installed at a kilovolt-ampere rating 15 per cent above the receiving-end transmission line kilovar requirements for correction to unity power factor of the receiver power at the receiving-end high-voltage terminal.

5. The cost of line compensation was assumed to be $10 per kilovolt-ampere for series capacitor compensation. This figure includes the necessary protective equipment and insulation above ground. An alternative method of compensation is to use special intermediate synchronous condensers which can be expected to be competitive with series capacitors.

6. A load factor of 50 per cent was assumed. Increased load factors will reduce the energy charge for transmission as the energy charge is almost inversely proportional to the load factor.

7. The transmission line power losses were evaluated at 4 mills per kilowatt-hour with annual equivalent hours of 3,300.

8. The transformer losses were evaluated at 4 mills per kilowatt-hour, 4,380 annual equivalent hours, and 0.6 per cent losses of total kilovolt-amperes of sending- and receiving-end transformer capacity.

9. Synchronous condenser losses were evaluated at 4 mills per

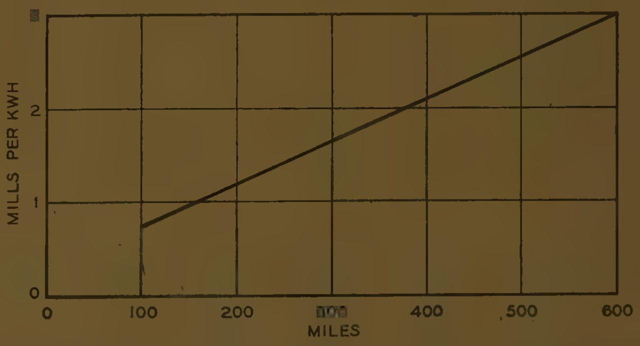

Figure 1. Cost of electric energy transmission at 50 per cent load factor based on 1.15 per cent annual charge on investment

200,000–350,000 kw per circuit

Essential substance of paper 47-163, "Economics of Long-Distance Power Transmission," presented at the AIEE summer general meeting, Montreal, Quebec, Canada, June 9–13, 1947, and scheduled for publication in AIEE *TRANSACTIONS*, volume 66, 1947.

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Figure 2. Lightning arresters and switches for 287-kv lines at Hoover Dam, Nev., formerly Boulder Dam

kilowatt-hour, 6,580 equivalent hours, and 1.7 per cent losses on their kilovolt-ampere rating.

10. The capacity charge for the transmission line plus transformer power losses was assumed as $100 per kilowatt.

11. The annual charges for interest, depreciation, taxes, and maintenance were assumed to be 11.5 per cent of the total investment cost.

200 TO 600 MILES

The stability limitations are more important for the longer distances. As a basis for the economic study of transmission in the range of 200–600 miles, the power transfer was taken equal to that which has an adequate steady state stability margin with representative terminal impedances. No line compensation and 50 per cent line compensation were studied in detail. On the basis of this study optimum costs are obtained with no compensation for distances up to about 200–300 miles, whereas 50 per cent compensation is the most economical for about 400–500 miles. Accordingly, greater line compensation than 50 per cent would be required for lines above 500 miles. However, it was not considered necessary to include this refinement of other degrees of line compensation in the study reported here, as such variations have been thoroughly investigated previously which show the desirability of increased compensation with increased distance.

Specific assumptions applied to this case (part *A*) in addition to the general assumptions of parts *A* and *B* previously mentioned are

1. Power transfer has 25 per cent steady state stability limit margin with typical terminal impedances. This will allow, in general, for the firm power transfer of lines so loaded when they are operated in parallel and provided with intermediate stations.

2. Intermediate switching stations were assumed to be located at every 100 miles to provide 100-mile line sections for switching. Also for comparison, the transmission costs were calculated, assuming no intermediate switching stations except those at the sending- and receiving-end terminals.

Somewhat lower transmission costs would have been obtained by assuming a smaller steady state margin corresponding to that of a single-circuit line without intermediate switching stations delivering power to a system with reserve system capacity sufficient to allow for a line outage in case of a fault. A reduction in energy transmission costs of about ten per cent may be possible

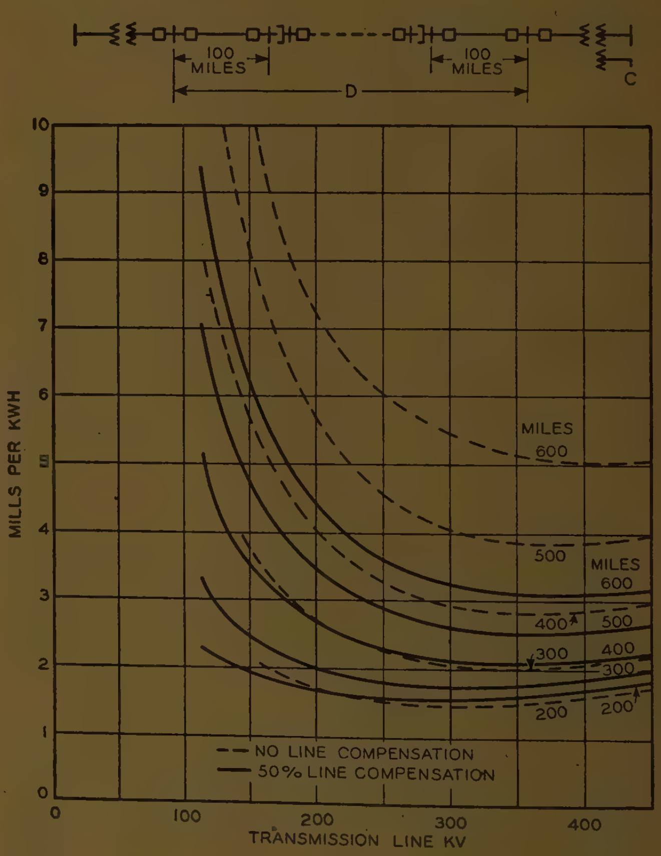


Figure 3. Mills per kilowatt-hour versus transmission line kilovolts

Intermediate stations every 100 miles
Load factor = 50 per cent
Annual charge = 11.5 per cent
$x = 0.8$ *ohm per mile*
$b = 5.2 \times 10^{-6}$ *mhos per mile*
Conductor resistance = 0.08 ohm per mile

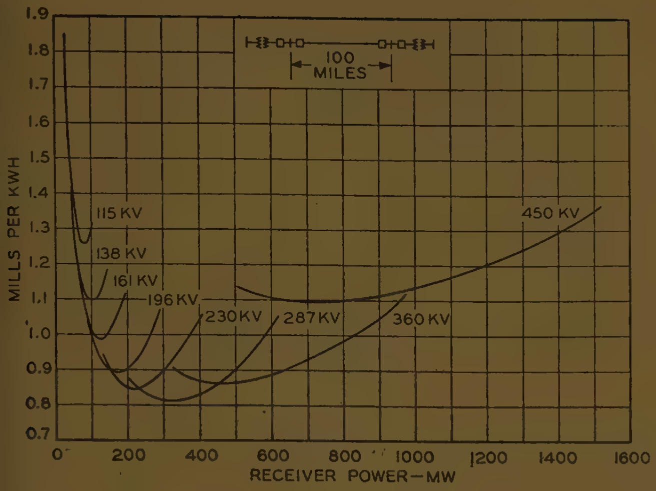


Figure 4. **Mills per kilowatt-hour versus receiver power in megawatts**

No line compensation
Load factor = 50 per cent
Annual charge = 11.5 per cent
x = 0.8 ohm per mile
b = 5.2 × 10^{-6} mhos per mile
Conductor resistance = 0.08 ohm per mile

under conditions such as these for the longer lines.

Equations to determine investment in dollars, annual charge in dollars per year, and energy costs in mills per kilowatt-hour were used to determine the results shown in Figure 3. For 200 miles of transmission, line compensation does not appear to be practical. For 600 miles, 50 per cent compensation of the line reduced the cost of energy transmission about 40 per cent from zero compensation.

For 400 miles, the cost with line compensation of 50 per cent is approximately equal to 300 miles with no compensation. Optimum economical line loadings range from surge impedance loading of the 600-mile line with 50 per cent compensation to 150 per cent of the surge impedance loading of the 200-mile line with no compensation.

100 MILES

Whereas stability is the chief limitation of the loading of the circuit for the longer distance, the most economical loading for 100-mile transmission will depend more upon the I^2R and I^2X losses. Because of this difference in limitations, the loading of the 100-mile transmission was varied to find the most economical point in preference to assuming the loading to be determined primarily by the stability power limit. Also, for this reason, it was unnecessary to include the effect of line compensation. Two circuit breaker positions per transmission circuit were assumed at both the sending and receiving ends with no intermediate stations. Otherwise, for this case, the same general assumptions and conditions previously described were used.

The equations used for this part of the analysis are the same as those used for part *A*, except that the receiving- and sending-end reactive kilovars were taken as equal to half the total line kilovar loss.

As shown for this distance (100 miles) in Figure 4 the optimum cost points occur at loadings appreciably above the surge impedance loading of 2.5 (kilovolts)².

200 MILES

This part summarizes the results of a study to determine some of the basic system design factors which would give optimum performance for the transmission of 1,000,000 kw a distance of 200 miles.

The transient stability limits were assumed to be the determining limitation for the transmission of power a distance of 200 miles. A transient stability study was made to determine the number of transmission line circuits required for the transmission line voltages of 230, 287, and 360 kv for a given system. An equivalent circuit was set up to represent the system on an a-c network analyzer. The system disturbance for determining the transient stability power limit was taken as a 3-phase fault occurring in front of one of the line circuit breakers at the sending bus and the subsequent switching out of the faulted line section.

From numerous curves showing transient stability power limit versus critical switching time for different transmission voltages and circuit parameters, Figure 5

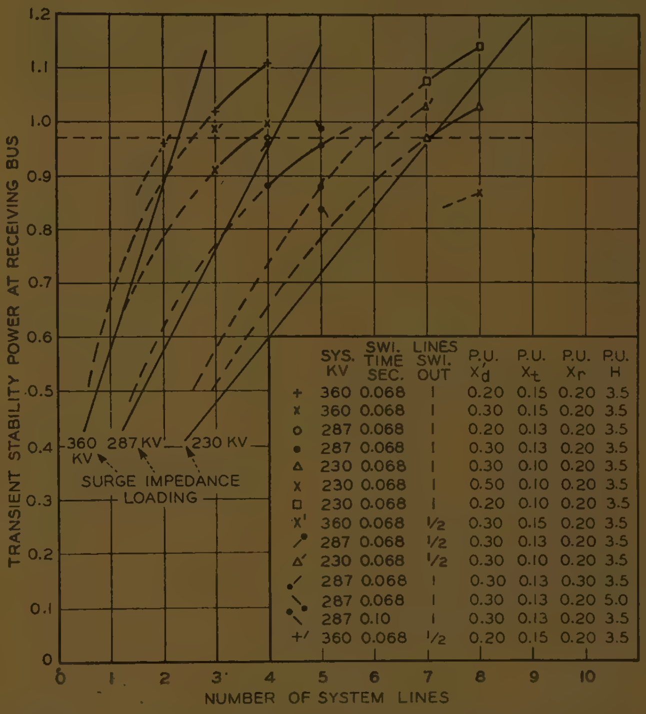


Figure 5. **Power received versus number of lines for transient stability**

1,000,000-kva plant
Base kilovolt-amperes = base kilowatts = 10^6
Initial sending bus voltage = 1.0 per unit
Initial receiving bus voltage = 0.957 per unit

was derived. Included in Figure 5 are curves of the approximate surge impedance or unity power factor loading of the lines at the various voltage levels based on the receiving bus voltage.

RESULTS OF CURVES

The results of Figure 5 indicate:

1. That 5 lines at 360 kv, 6 lines at 287 kv, and 8 lines at 230 kv will be required with 4 cycles fault clearing and with generators having a transient reactance of 30 per cent and an inertia constant of 3.5 kilowatt-seconds per kilovolt-ampere.

2. That increasing the inertia constant from 3.5 to 5, or 43 per cent, produces an increase of transient stability power of about 3 per cent.

3. That decreasing the generator transient reactance from 30 per cent to 20 per cent increases the transient stability power about 10 per cent and permits the elimination of one transmission line for all three voltage levels.

4. That increasing the equivalent receiving reactance from 20 per cent to 30 per cent decreases the transient stability power about 10 per cent.

5. That increasing the switching time or duration of the fault from 0.068 second to 0.1 second, or 47 per cent, decreases the transient stability power about 12 per cent.

6. That using an intermediate switching station such that one half of a line is switched out instead of one line, increases the power limit by 8 per cent and allows the elimination of one line for all three voltage levels.

7. That eight lines operating at 230 kv with a generator transient reactance of 30 per cent have a transient stability power limit when switching out one line equal to the surge impedance loading of all of the lines, similarly for five lines operating at 287 kv with a generator transient reactance of 20 per cent.

Figure 6 was obtained for a power received of approximately 970,000 kw showing the number of lines required with no intermediate switching stations, and the number of lines required with one intermediate switching station as a function of system voltage. The three system voltages chosen lie on the knee of each curve, indicating that they are in the region of the most economic cost for transmission.

Table I. Surge Impedance Loadings Per Circuit of Typical Transmission Lines

Line Kilovolts	2.5 (Kilovolts)² Surge Impedance Loading in Kilowatts
115	33,000
138	47,600
161	65,000
194	96,000
230	132,000
287	206,000
360	324,000
450	505,000

Surge impedance taken equal to 400 ohms per phase to neutral resulting in surge impedance loading in kilowatts = 2.5 (kilovolts)².

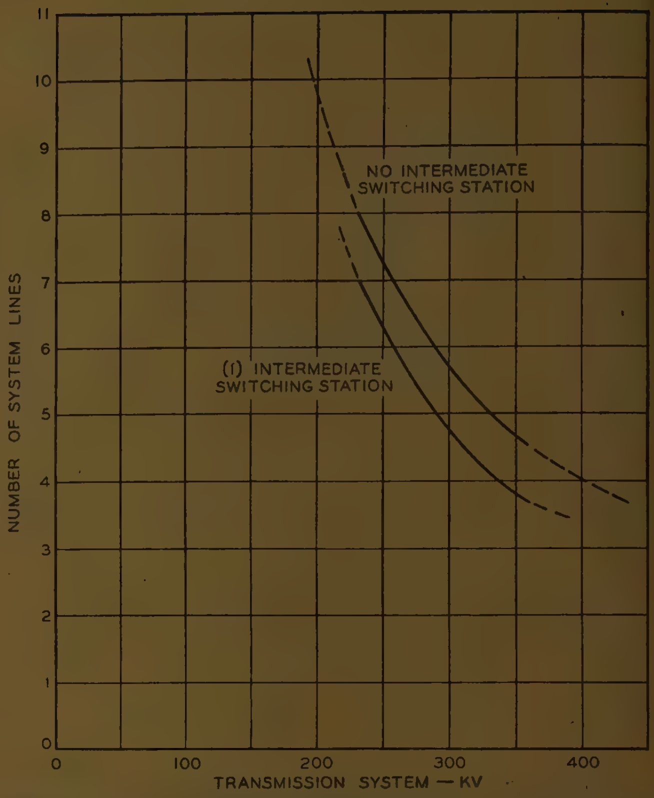


Figure 6. System stability requirements; number of lines versus system voltage

1,000,000-kva plant
200 miles transmission distance
Power at receiving bus = 970,000 kw approximately

An installed cost comparison of transmission systems with and without intermediate stations is shown in Figure 7 with generators of 30 per cent transient reactance, inertia constant = 3.5 kw-seconds per kilovolt-ampere, and with a receiving system reactance = 0.20 per unit.

A cost comparison of systems using different generator transient reactances indicate that 20 per cent rather than 30 per cent is fully justified economically. The lower generator reactance system requires one less transmission line than the system using the higher value of generator transient reactance = 0.30 per unit.

Although this analysis was made on a somewhat different basis from that of parts *A* and *B*, it indicates not much difference in transmission cost for the three voltages of 230 kv, 287 kv, and 360 kv with a slightly lower cost for 287 kv.

CONCLUSIONS

Based on the results of this study, the following conclusions have been drawn.

1. The cost of a-c energy transmission given by Figure 1 may be attained by rational transmission system design for power transfers of 200,000 to 350,000 kw per circuit, for a load factor of 50 per cent, and an annual charge on investment of 11.5 per cent. Higher load factors or lower annual charges will reduce the transmission costs. Since energy transmission costs are chiefly those of invest-

ment, the cost is almost inversely proportional to the load factor and almost directly proportional to the annual charge.

2. Line compensation by either series capacitors or special intermediate synchronous condensers becomes desirable for straightaway transmission distances exceeding 200–300 miles. Below these distances, line compensation does not appear to be justified.

3. The 287-kv voltage level is about the most economical for power transfers of 200,000 kw per circuit for straightaway distances of 300 miles and for higher loadings at shorter distances up to 350,000 kw per circuit for 100 miles.

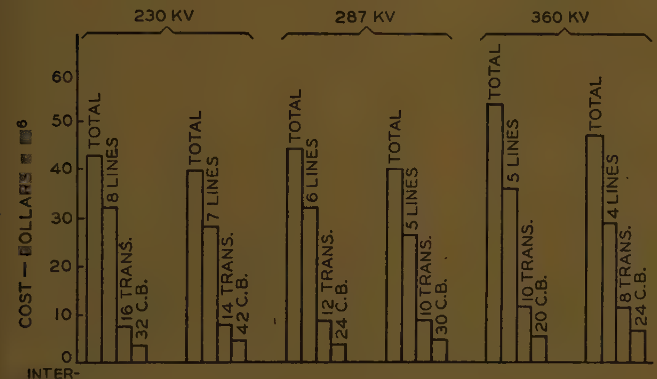
4. The 360-kv voltage level is about the most economical voltage for distances in the range from 300 to 600 miles when line compensation is used for power transfers of 300,000–350,000 kw per circuit.

5. The difference in energy transmission costs for any two voltage levels near the optimum is relatively small even for the same power transfer and becomes practically inconsequential when the optimum economical loadings for each of the voltages are used.

6. The terminal transformer costs approach that of the transmission line when the line length is in the range of 100 miles.

7. Transformer costs limit the use of higher voltages than 360–400 kv for the shorter distances, whereas for the longer distances up to 600 miles circuit breaker costs also limit the use of higher voltages when intermediate stations are used.

8. Operation of high-voltage systems with grounded neutrals materially reduces the transmission costs by allowing for the use of the next lower level of transformer insulation as well as reducing the transmission line costs.



INTERMEDIATE STATIONS	0	1	0	1	0	1
P_R	0.97	0.95	0.96	0.96	1.0	0.99
P_Z	0.96	0.84	1.14	0.95	1.48	1.19
P_R/P_Z	1.01	1.13	0.84	1.01	0.68	0.83

Figure 7. Installed cost of transmission systems

Receiver reactance = 0.20 per unit
Generator reactance = 0.30 per unit
Generator inertia constant = 3.5 per unit
P_R *= per unit transient stability received power limit*
P_Z *= per unit surge impedance loading*
Base kilovolt-ampere = base kilowatt = 10^6

9. The lower resistance conductors result in generally lower transmission costs over a greater range of loads even for load factors as low as 50 per cent. Also, since the larger conductors have a greater emergency loading, they, in general, will be preferred.

10. The most economic kilowatt loading varies from 60 per cent above the surge impedance loading at 100 miles (uncompensated line) to about the surge impedance loading 2.5(kilovolts)^2 for a distance of 600 miles (compensated line). See Table I for representative surge impedance loadings.

Transformers being built by Westinghouse Electric Corporation for an experimental 500-kv transmission line of the American Gas and Electric Service Corporation

11. Hydroelectric generators and their step-up transformers delivering power to long distance transmission systems justifiably can be built with lower-than-normal reactance.

12. Multiple transmission lines with more or less parallel rights of way used for firm power supply can justify economically intermediate switching stations located about every 100 miles.

13. Electric energy transmission at high load factors in substantial amounts, of the order of 200,000–350,000 kw per circuit, making full use of present-day knowledge and equipment becomes more competitive than formerly with other methods of transporting energy and can be expected to be accorded a correspondingly renewed interest.

14. Systems are now entering a stage in their development where added generating capacity will be located at relatively greater distances from the utilization areas. The economics of power transmission, therefore, will be in the direction to encourage the development of large generating stations for connection to well-integrated systems so that the transmission may be accomplished at high circuit loadings and load factors.

INSTITUTE ACTIVITIES

Engineering—Instrument of Peace

As time goes, it was not too long ago that America's pioneer plowman carried a musket as standard equipment. Today, we find the blueprint on the factory desk alongside the machine. The musket and the blueprint are, in many respects, similar symbols. Both have two implications—they are symbols of either destruction or security.

It is becoming more apparent, each day we live, that the co-ordinated skills of engineering are the instruments by which we will achieve either one or the other of these ends—and we are daily in much we do and say making our choice. I choose to believe that mankind will not elect to use engineering in a way whereby its end results will mean self-obliteration.

Let us look, therefore, at the engineer's position as an important benefactor of society. Does the man in the street recognize the engineer as such? Perhaps, to some degree. But surely not fully enough. One of the engineer's greatest handicaps in working toward recognition is his unaccountable modesty and lack of articulation. The politicians, the social workers—they have made their catch phrases a part of our language. The engineer has not. To him it was merely a matter of business to accomplish great deeds with few phrases—to establish good housing, to introduce water and sewage systems, to promote the better life through the introduction of electricity into factories and homes and far places. It is time for the engineer to speak up.

Concerning our own Institute, I want to state that no greater opportunity for good ever has presented itself to unselfish men than that which rests today—right now—in the palm of the electrical engineer's hand. He has in his grasp the magic of electricity. In many instances he has applied this magic toward achievements which have brought a more complete understanding among the peoples of the world. But even greater opportunities face him. Cashing in on them depends largely on the engineer's ability to tackle and accomplish the great task of co-ordination—of both thinking and effort. Grouped in harmony, engineers provide the means to wonders beyond the powers of the genie of Aladdin's lamp—wonders which the mind of any single person cannot encompass.

The engineer, through vision, courage, and teamwork, has industrialized the Western Hemisphere. I believe that this formula can be applied to a total and complete "design for living." In the United States, for example, the electric generators, installed in utility and industrial plants combined, as of 1945, represented a kilowatt output exactly twice that of 1935. Out of this flow the thousands of electrical applications which are such a large part of our "design for living." How much additional generation is forecast for the next ten years? Perhaps more than 60 million kw, depending upon the vision and unified courage of our engineers. Courage implies confidence. The electrical engineer can prosecute his work with a high degree of confidence that his profession is one which can be of unlimited service to humanity.

In this important work, the electrical engineer should know that his professional associates do not wish to be bound by authoritarian, restrictive dogmas. A recent poll of AIEE membership brought out our group opinion on the relationship of the engineer and labor laws. A summary of the results of this poll has been published (*EE, June '47, pp 594–5*).

In keeping with these principles the electrical engineer has a serious responsibility. He may work with many organizations, but he elects to keep himself unfettered of the bonds of uniformity of hours, wages, incentives, and work. Unity of thought, expression, and effort does not involve restrictions or blindfolds. However, he must not overlook the productive areas of co-operation between management and labor in achieving a well-ordered plan for working and living.

Functional co-operation can be achieved only through unity within the profession. Why are we concerned with this unity of function? Because it is essential if mankind is to have a greater opportunity in the future for improved educational, cultural, and social satisfactions.

What can we do to assist in developing the field of engineering as an instrument of peace and better living? For one thing, we can throw our support behind the far-thinking educators in our engineering colleges who insist that cultural training is as essential in engineering education as good technical training. We also must take the lead in enhancing the individual status of the engineer by maintaining the high ethical and moral standards of the profession.

Society has shifted gears. It is running "in high" at all times. Instant communication with the four corners of the world brings the impact of every important happening into the family circle immediately. Inevitably, this speeds the development of ideas—and the conversion of ideas into action. Little time is allowed us for sober reflection on many decisions we must make. Yet we have come to the Valley of Decision in many of our affairs—particularly our engineering affairs.

What direction must we take? We must decide our problems with one goal always before us—peace, security, and better living for all. With this in mind we must consider our relations with other professions; our function as the technical arm of management in an industrial civilization; and especially the way in which we conduct our daily lives, separately and together.

We must preserve our unspoken policies of operating in full freedom of association; of offering nonpolitical service in public affairs; and of becoming more articulate in the expression of our ideals and dedication to the common good of all men.

This has been a pleasant year, because it has been a pleasure for me to serve the Institute as one of its officers. The bond of fellowship, the spirit of mutual helpfulness among the members, the co-operation afforded the officers and staff by the members was displayed in remarkable degree during my visits to many Sections, Subsections, Student Branches, and District and general meetings attended during the year. Pervading the meetings of executive committees of Sections was the same strong spirit of the electrical engineer in fostering the development of a firm policy of high standards in our profession. Substantial evidence has been published confirming observations made by many hundreds of divisional officers and general officers of the Institute in the United States relating to participation of engineers in public affairs. Specific reference is made to the report of the professional activities subcommittee (*EE, May '47, pp 496–7*).

Translation of theory into practice, thought into action, will be accelerated in the body of the membership by synchronized pulsed application of the magnetic interest of your newly installed president, Mr. Blake D. Hull.

Essentially full text of an address by President J. Elmer Housley to the annual meeting of the AIEE, held June 11, 1947, in Montreal, Quebec, Canada.

The President's Responsibilities

First, I wish to express to all members of the Institute my appreciation of the great honor that has been conferred on me in my being elected your president for the ensuing year. The office is one of great distinction. We are 63 years old this year and number over 27,000 members, the largest engineering society in the world. Many renowned engineers have helped to fashion the Institute into what it is today—an important factor in the shaping of many of our ways of life. I indeed would be embarrassed by my personal inadequacies, did I not realize that the success of the Institute depends not so much on the ability of the president or his activities, as upon the ability and activities of the thousands of members scattered over the continent who are willing to contribute so much to the success of the organization through their work in the Sections and the committees.

My first responsibility, and it is a difficult one, is the task of setting up the national committee organization. That includes some 900 names. At best I can know personally only a few of those to be appointed. Fortunately, I have available the suggestions of the Sections, the District vice-presidents, the current chairmen of the committees, and various individual members. I shall follow their suggestions as well as I can, and I hope that those who are asked to serve will do so and will carry on to the best of their ability.

There are a number of projects started during the administrations of my predecessors which I hope can be carried forward to completion just as soon as possible.

About two years ago Doctor Wickenden suggested that the planning and co-ordinating committee study the whole field of intersociety relationships, as well as the adequacy of the Institute's internal committee, Section, and staff organization to deal constructively with the developments confronting the electrical, in particular, and, in a general way, all engineers. Mr. Fairman promptly appointed two subcommittees, one to study the technical activities and the other to study the professional activities of the Institute and their integration with similar activities of other engineering societies. President Housley has continued this project and given it his enthusiastic support.

These subcommittees have submitted, and the board of directors has adopted, a number of constructive recommendations covering some of the more routine administrative affairs of the Institute. I think you are familiar with them. In addition, they have undertaken two important projects in which I am particularly interested.

The first of these provides for a greatly needed regrouping of the Institute's committee setup. This will aid in a better selection of committee members. Also, with the increasing number of committees, it is necessary to relieve the board of directors of some of its responsibility for co-ordinating their activities.

A step in that direction has been authorized by the board in dividing the technical committees, of which there are 30 in existence or authorized, into four groups with a co-ordinator in each to promote closer co-operation among them. There is no activity more important to the success of the Institute than its technical activities, and they must not be hampered. But there is a general belief, which I share, that we have outgrown the old arrangement and that a change is overdue. The proposed grouping of the technical activities, or something similar, will permit a better selection of committee personnel and a better co-ordination of their activities.

The board also has authorized a grouping of certain of the nontechnical committees into two divisions, "professional" and "administrative," to which I also subscribe. All of these changes are made with the understanding that they will be tried out for a time and then officially adopted if found satisfactory. We should try them honestly and fairly and evaluate their effectiveness without bias.

The professional subcommittee has devoted itself principally to the broader objective of finding an organization through which all engineers could advance more adequately their professional welfare and discharge their responsibilities to society. The committee has made its report and recommendation based on a sampling of the members' opinion in all parts of the country. I think all of you have participated at one time or other in discussion of the problem and are familiar with it. The subcommittee's report was submitted to a committee of past presidents who have reviewed it and made such changes as appeared desirable. It has been published and I hope you all will read it.

While there are many differences of opinion and conflicting views of how the objective can be accomplished, I am satisfied that the majority of the members of the Institute are in favor of the organization proposed by the subcommittee, or some similar setup. During recent months I have read articles written by past presidents of the civil, mechanical, and mining engineering societies, our own organization, and others, and I find that, as far back as the 30's, their thoughts were directed toward a national all-inclusive society. The feeling is that generally the existing engineering societies, in spite of some overlapping and duplication, are carrying out their technical functions satisfactorily and with reasonable efficiency. Where this is not the case, they have within their organizations sufficient capacity to expand such activities to any extent needed. In respect to the engineer's professional development, improvement of his economic status, his responsibility to society, in short, all interests outside of his strictly technical preoccupation, the existing societies by their very nature are inadequate individually.

I shall use the name American Engineering Association as a descriptive term for the kind of an organization the subcommittee had in mind. While I do not propose to recommend to the membership just how this over-all society is to be organized, I am convinced that the technical functions and activities of any national engineering society should not be disturbed in this move, except to the extent that overlapping and duplication of effort can be eliminated by voluntary action. This is a big program. It will require the most strenuous effort and the utmost of co-operation on the part of all the societies. I hope this can be obtained and some real progress made during the coming year.

Before an organization of this kind can be set up, it seems to me advisable that all participating societies adopt uniform grades of membership with similar qualifications for each grade. This should not be difficult to accomplish and is already under consideration by the Engineers' Council for Professional Development.

I wish to point out that in expressing my thoughts on what constitutes a workable organization to which all engineers can belong to make their influence felt, I am speaking as an individual member. As president of the Institute, it will be my object to carry on with this project, so that there may be worked out some suitable organization, whether it be an American Engineering Association or some other.

A moment ago I mentioned the age of the Institute—63 years. Sixty-three years have no particular significance, insofar as age of institutes is concerned, but it does bring to mind the need for constant vigilance on our part so that the Institute will remain vital and effective.

One of the most positive means of keeping an organization active and effective is a constant flow of new members, young in years, and enthusiastic in spirit. I shall support any plan that best meets that objective, and I look forward to serving you to the best of my ability.

Essentially full text of the response by Blake D. Hull to the presentation of the AIEE president's badge at the annual meeting of the Institute in Montreal, Quebec, Canada, June 11, 1947.

Night in Mexico to be Feature of Pacific General Meeting in San Diego

All is in readiness for the AIEE Pacific general meeting to be held in San Diego, Calif., August 26–29, 1947. A varied program of entertainment, sports, and trips, with special features for the visiting women, combined with the recreational activities which San Diego has to offer, provides attractive vacation possibilities. Those who have not visited the city since before the war will find many interesting changes. The program committee suggests: "Plan your vacation for the dates of the meeting and stay around as long as you can." Headquarters for the meeting will be in the Hotel San Diego.

ENTERTAINMENT

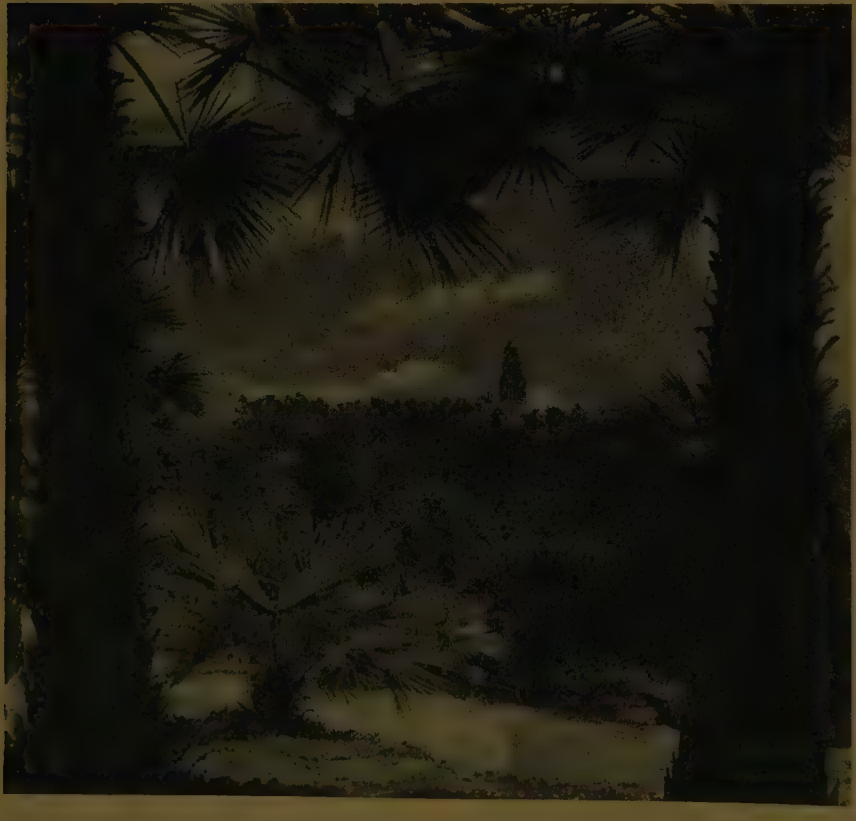
The president's reception and cocktail party will be held Tuesday, August 26, at 6:00 p.m., in the Continental Room, San Diego Hotel. Entertainment will be provided, and the party will be without charge for all who are registered.

At noon, Wednesday, a luncheon will be held in the Continental Room, and the committee has been fortunate in obtaining for the occasion Blake D. Hull (F '39) AIEE president elect, who will speak on "Organization of an American Engineering Association."

A highlight of the meeting will be "A Night in Old Mexico," Wednesday, August 27. Transportation will be provided and will leave San Diego at 6:00 p.m. Dinner will be served at Serena's in Tijuana, after which guests have their choice of a program of dancing and entertainment, or greyhound races, or strolling among the cafes, shops, and streets of this Mexican town. No passport is needed to cross the border.

For Thursday noon a 2-hour boat ride around San Diego Bay is scheduled, with picnic lunch served on board. Women are invited. Points of interest to be seen from the boat are the enormous Naval Air Station on North Island; the tuna fishing fleet; United States Fleet Sonar School; San Diego, Coronado, and Southwestern Yacht Clubs; the United States Coast Guard Air Base; Ballast Point and the Naval Fueling Station; kelp processing and salt plants; the Naval Training Center; Naval Amphibious Base; Marine Corps Base; the Naval Repair Base with its 300-vessel reserve fleet; submarines, destroyers, and aircraft carriers at anchor; and the commercial waterfront of San Diego.

An informal banquet will be held Thursday evening in the Continental Room and entertainment will include the presentation of golf and students' prizes.



California Tower through archway of Palms in Balboa Park, San Diego

Future AIEE Meetings

Pacific General Meeting

San Diego Hotel, San Diego, Calif., August 26–29, 1947

Middle Eastern District Meeting

Biltmore Hotel, Dayton, Ohio, September 23–25, 1947

Midwest General Meeting

Congress Hotel, Chicago, Ill., November 3–7, 1947

Winter General Meeting

William Penn Hotel, Pittsburgh, Pa., January 26–30, 1948

WOMEN'S ENTERTAINMENT

Several events are planned especially for the entertainment of the women registered at the meeting. Tuesday afternoon a smorgasbord-style luncheon and bridge party will be held at Imig Manor. This establishment is built around a central courtyard, and swimming pool, and the swimming facilities may be used.

Wednesday afternoon a sightseeing tour to La Jolla and Point Loma is planned. Points of interest to be seen will be Mount Soledad, La Jolla cove and caves, La Jolla Beach and Tennis Club, Scripps Institute of Oceanography, Mission Bay, Pacific Beach, Mission Beach, Ocean Beach, Naval Electronics Laboratory, Fort Rosecrans, and the incomparable view of San Diego, Coronado Islands, and San Diego Bay from the old Spanish lighthouse at the Cabrillo national monument, on the tip of Point Loma.

STUDENT ACTIVITIES

Nearly all of the 13 colleges and universities in Districts 8 and 9 have indicated that they expect to be represented in San Diego by staff members and Student members.

Student sessions are planned, and papers will be presented from California Institute of Technology, University of Southern California, University of Santa Clara, Stanford University, University of Utah, Oregon State College, and University of Idaho.

SIGHTSEEING AND MISCELLANEOUS

On Saturday, for those interested, a trip will be arranged to Palomar Observatory, site of the new 200-inch telescope of the Rockefeller Foundation. The extent to which visitors can be permitted inside the observatory building will depend upon progress of the installation of the 200-inch mirror, which is expected to occur about that time.

August is the height of the deep-sea-fishing season off San Diego, when yellowtail, sea bass, barracuda, mackerel, and bonito abound. Members interested will be assisted in participating; if sufficient interest is shown, a boat will be chartered exclusively for AIEE people.

AIEE PROCEEDINGS

Order forms for AIEE *PROCEEDINGS*, and abstracts of the papers included, have been published in *ELECTRICAL ENGINEERING* as listed below. Each section of *PROCEEDINGS* contains the full formal text of a technical paper including discussion, if any, as it will appear in the annual volume of *TRANSACTIONS*. *PROCEEDINGS* are issued in accordance with the revised publication policy that became effective January 1947 (*EE, Dec '46, pp 576–8; Jan '47, pp 82–3*), and are available to AIEE Associates, Members, and Fellows.

Meetings	Abstracts	PROCEEDINGS Order Forms
Winter	Jan '47, pp 84–93; Feb '47, pp 190–1	Feb '47, pp 33A and 34A
North Eastern District	Apr '47, pp 401–02	June '47, pp 55A and 56A
Summer General	June '47, pp 607–14; July '47, p 708	

Registered visitors will be assisted and encouraged to plan a week with as full and varied entertainment as suits their tastes. Among the items available will be visits to San Diego Zoo, Balboa Park, Del Mar Race Track, surf bathing beaches, Pacific Coast League baseball, and jai alai games. The Actors' Company at La Jolla Playhouse, and Star Light Opera at Wegeforth Bowl, will be giving performances every night during the week of the meeting. San Diego Fine Arts Society is exhibiting an ever-growing collection, and the Serra Museum in Presidio Park will be of interest, located on the spot where colonization of California began in 1769.

GOLF

A golf tournament will be held Thursday afternoon, August 28, at the Chula Vista links of San Diego Country Club. A perpetual trophy, the John B. Fisken Cup, will be awarded for the best 18-hole medal round on handicap, and there also will be prizes for a kicker's handicap and for best low net among registered nonmembers. Transportation to the country club will be arranged for those desiring it.

INSPECTION TRIPS

Aircraft Carrier. A 27,000-ton flattop of the *Essex* class will be moored at Broadway Pier, just a short walk or bus ride from meeting headquarters, and the Navy has invited AIEE members and their guests aboard Tuesday afternoon. They will be given tours through the ship, permitting inspection of the hangar and repair facilities, armament, living accommodations of the crew, and several types of Navy aircraft, including jet-propelled airplanes and a giant *PB2Y-3* flying boat, which will be hoisted on board. There will be a demonstration of a jet-propelled airplane in flight overhead.

AIEE Pacific General Meeting, Tentative List of Papers

Aircraft

47–197. D-C Aircraft Generator Power Center. **E. L. Bottemiller**, General Electric Company

47–202. Ground Power Supply for Modern Aircraft. **T. B. Owen, J. A. Murray**, Douglas Aircraft Company; **Allan Rosenstein**, lecturer in engineering, University of California, and consulting engineer, Industrial Electronics and Transformer Company

47–205. Electric Equipment Required in a Modern 6-Component Wind-Tunnel Model Suspension System. **H. Orville Cox**, Bechtel Brothers McCone Company

47–179. Automatic Temperature Control for Transport Airplanes. **R. E. Hedges**, Douglas Aircraft Company, Inc.

CP.* Engineering Maintenance of Aircraft Electrical Systems. **J. A. Aldrich, J. R. Grace**, United Air Lines, Inc.

CP.* Electrical Prerotation of Landing Gear Wheels. **J. H. Keyser, Jr.**, Lockheed Aircraft Corporation

47–176. Capacitance Fuel Gauges. **N. C. Clark, M. H. Adolphe**, Lockheed Aircraft Corporation

Communications—Electronics

CP.* Some Observations on the Design and Maintenance of Low-Distortion Audio Systems. **J. R. McGaughey**, Naval Electronics Laboratory

CP.* Random Phenomena and Signal-to-Noise Ratio. **Simon Ramo, R. H. Delano**, Hughes Aircraft Company

47–198. Design and Application of Supersonic Flaw Detectors. **D. C. Erdman**, Triplett and Barton, Inc.

CP.* Application of Radio on Power Systems. **L. E. Ludekens**, Southern California Edison Company

CP.* Design of Electronically Regulated D-C Power Supplies. **D. C. Kalbfell**, Kalbfell Laboratories

Industrial

CP.* Design Problems Encountered in Capacitor Stored Energy Spotwelding Equipment. **John C. Rapp**, Lockheed Aircraft Corporation

47–186. General Analysis of Speed Regulators under Impact Loads. **G. D. McCann**, California Institute of Technology; **W. O. Osbon, H. S. Kirschbaum**, Westinghouse Electric Corporation

47–181. A New Grinding Circuit Feed Regulator. **J. N. Jones**, Westinghouse Electric Corporation

—PAMPHLET reproductions of author's manuscripts of the numbered papers listed in the program may be obtained as noted in the following paragraphs.

—ABSTRACTS of most papers appear on pages 840–2 of this issue.

—PRICES and instructions for procuring advance copies of these papers accompany the abstracts. Mail orders are advisable, particularly from out-of-town members, as an adequate supply of each paper at the meeting cannot be assured. Only numbered papers are available in pamphlet form.

—COUPON books in five-dollar denominations are available for those who may wish this convenient form of remittance.

—THE PAPERS regularly approved by the technical program committee ultimately will be published in PROCEEDINGS and TRANSACTIONS; essential substance of many will appear in ELECTRICAL ENGINEERING

CP.* Speed Control for Monorail Cranes. **L. J. Rich**, Lockheed Aircraft Corporation

CP.* Field Problems in Balancing Rotating Electric Machinery. **R. B. Barton**, General Electric Company

CP.* Electrolytic Cleaning of Rectifier Tanks. **C. K. Ittner**, Aluminum Company of America

Irrigation

Address: Colorado River Water Allotment and Power Generators. **W. S. Peterson**, Los Angeles Department of Water and Power

Power

47–203. A Simple and Inexpensive Method for Accurately Measuring Steady-State and Transient Voltages on High Voltages. **H. L. Levinton**, Bonneville Power Administration

47–199. Excitation Problems in Hydroelectric Generators Supplying Long Transmission Lines. **C. L. Killgore**, United States Bureau of Reclamations

47–184. The Design and Performance of the Vertical Generator Thrust Bearings at the Bonneville Plant of the Corps of Engineers, War Department. **F. M. Lewis**, War Department; **T. W. Gordon**, General Electric Company

CP.* Conductor Vibration Studies on Energized 230-Kv Transmission Lines. **M. G. Poland, M. B. Elton**, Bonneville Power Administration

47–175. Broken Conductor Effect of Sags in Suspension Spans. **Alfio Bissiri, Maurice Landau**, Department of Water and Power, City of Los Angeles

47–180. Tests and Developments in Connection with Hot-Line Insulator Washing. **G. Leslie Hill**, Pacific Gas and Electric Company

47–185. Circuit-Breaker Current Measurement During Reignitions and Recovery. **L. J. Lewis**, University of Washington

Selected Subjects

47–201. An Electro-Optical Shutter for Photographic Purposes. **A. M. Zarem, F. R. Marshall, F. L. Poole**, United States Naval Ordnance Test Station

CP.* The Analysis of Retarded Control Systems. **L. A. Pipes**, Hughes Aircraft Company

CP.* A Derivative-Computing Servomechanism for Power System Governing. **T. E. Curtis**, Pacific Gas and Electric Company

Symposium on Sonar

CP.* General Survey of Sonar Development. **Rawson Bennett**, Navy Electronics Laboratory

47–195. A Bearing Deviation Indicator for Sonar. **O. H. Schuck**, Minneapolis-Honeywell Regulator Company; **C. K. Stedman**, Boeing Aircraft Company; **J. L. Hathaway**, National Broadcasting Company

47–182. Submarine Detection by Sonar. **A. C. Keller**, Bell Telephone Laboratories, Inc.

CP.* The Application of Sonar to Harbor Defense and Amphibious Landing. **Elias Klein, T. F. Jones**, Naval Research Laboratory

CP.* The Instrumentation and Techniques of a Sonar Calibration Station. **Cecil Burbank**, Navy Electronics Laboratory

CP.* Echo Repeater Practice Target System for Training Sonar Operators. **D. G. Reid, W. L. Bryant**, Navy Electronics Laboratory

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*CP: Conference paper; no advance copies are available; not intended for publication in *TRANSACTIONS*.

Approximate Hotel Rates

Hotel	Single Bed	Rooms with Double Bed	Twin Beds	Suite or Cottage
San Diego		$2.50–5.00	$5.00–8.00	$5.00–8.00
Botsford	$2.50–5.00	2.50–5.00	2.50–5.00	
Del Coronado*	8.00–12.00		Over 12.00	
El Cortez	5.00–8.00	8.00–12.00	8.00–12.00	
U. S. Grant		5.00–8.00	5.00–8.00	
Holland		2.50–5.00		
Imig Manor				Over 12.00
Knickerbocker		2.50–5.00	2.50–5.00	
New Palace		2.50–5.00	5.00–8.00	
New Plaza		2.50–5.00	2.50–5.00	
Pickwick		2.50–5.00	5.00–8.00	

* American Plan.

Tentative Schedule of Events

Tuesday, August 26

8:00 a.m.	Registration
9:30 a.m.	Opening general meeting
10:30 a.m.	Technical session: Irrigation
12:00 noon	Luncheon meeting
12:30 p.m.	Women's luncheon and bridge party at Imig Manor
1:30 p.m.	Inspection trip: Visit aboard aircraft carrier
2:00 p.m.	Technical session: Selected subjects
	Student technical session
6:00 p.m.	President's reception and cocktail party

Wednesday, August 27

9:30 a.m.	Technical session: Aircraft
	Technical session: Power
	Leave for inspection trip: Solar Aircraft Company
12:00 noon	Luncheon meeting. Speaker: Blake D. Hull, president AIEE, on "Organization of an American Engineering Association."
1:30 p.m.	Women's sightseeing trip to La Jolla and Point Loma
2:30 p.m.	Technical session: Aviation
	Student technical session
	Leave for inspection trip: Silver Gate station
6:00 p.m.	Leave for evening program in Tijuana, Mexico, or Jai Alai game

Thursday, August 28

9:30 a.m.	Technical session: Communication–Electronics
	Technical session: Industrial
11:30 a.m.	Leave for boat ride around San Diego Bay. Picnic luncheon served aboard. Women invited
2:00 p.m.	Start of golf tournament at San Diego Country Club, Chula Vista
	Technical session: Communication–Electronics
	Technical session: Industrial
7:00 p.m.	Banquet and awarding of prizes
	Informal
	Speaker: Doctor A. W. Bellamy on "Biological Significance of the Bikini Tests"

Friday, August 29

9:30 a.m.	Technical session: Power
	Symposium on Sonar
	Leave for inspection trip: Consolidated Vultee plant
12:00 noon	Luncheon
2:00 p.m.	Technical session: Power
	Symposium on Sonar (continued)
2:30 p.m.	Leave for inspection trip: Naval Electronics Laboratory

The *Essex*-class ships are large carriers, many of which, including the famous *U.S.S. Franklin* and *U.S.S. Bunker Hill*, saw action in the last war. They displace 33,000 tons when fully loaded, are 856 feet long, carry 150,000 horsepower of propulsion machinery and a complement of over 2,500 men.

Solar Aircraft Company. For members interested in resistance welding of stainless steel products, an inspection trip has been arranged to visit the San Diego plant of Solar, largest manufacturers in the world of aircraft exhaust manifolds. Some of the other products are high temperature parts for gas turbines, stainless steel caskets, dairy equipment, and cooling tower fan blades. This trip is limited to 25, and those desiring to go are cautioned to register well in advance. Silver Gate station is the newest generating station of the San Diego Gas and Electric Company, and is laid out for an ultimate installation of four turbine-generators. It now has one 43,000-kw machine, placed in service in January 1943, which is served steam at 850 pounds per square inch and 900 degrees Fahrenheit. Unit 2, of 50,000-kw rating, and its accessories now are being erected.

Consolidated Vultee Aircraft Corporation. This company's main plant is located in San Diego and was the birthplace of such famed wartime airplanes as the *B-24 Liberator*, the *PBY Catalina*, the *PB2Y Coronado*, and the *B-32 Dominator*. AIEE members and guests will be allowed an extended tour of the nonrestricted areas of the plant, including the *XC-99*, largest transport airplane in the world, now nearing completion; the mockup area; the new wind tunnel; and the production line of the *Convair 240*, new 40-passenger airliner of which more than 100 are on order by domestic and foreign airlines.

United States Navy Electronics Laboratory. Located on Point Loma, this is an organization of civilian scientists and engineers, aided by naval officers and men, working on the design, procurement, testing, installation, and maintenance of fleet electronic equipment. Among the items included in the inspection tour will be the antenna model range on a "simulated ocean," where radiation patterns are taken from proportionate ship models, a sonar operators' training device, lightweight radar in operation, and displays showing special crystal transducers and sonar detection and ranging principles.

HOTELS

Those who will attend the meeting should make reservations by writing directly to the hotel preferred. Although arrangements have been made for sufficient blocks of rooms for the number expected to attend, they will be held until meeting time only, if specifically reserved by those who will occupy them, and travel to San Diego in August is particularly heavy because of the concurrent race meeting at Del Mar Turf Club.

ADVANCE REGISTRATION

Those who will attend the meeting and who have received an advance registration card by mail should register in advance by filling in and mailing the card promptly. This will be of great assistance to the committees making arrangements.

COMMITTEES

The following is a tabulation of the various committees and their members who are conducting the activities of the meeting.

General Committee

J. F. Sinnott, *chairman*
B. B. Gravitt, *vice-chairman*
W. J. Kenline, *secretary*
R. T. Strong, *treasurer*
W. M. Allen
F. J. Bartholomew
I. W. Best
D. I. Cone
A. V. Eastman
F. F. Evenson
J. R. Jarvis
C. F. McCabe
E. W. Morris
D. H. Olney
W. L. Smith
C. F. Terrell
A. Tilles
W. J. Warren
E. W. Williams

Subcommittee Chairmen

C. J. Breitwieser, *technical*
J. P. Conner, *hotel and registration*
O. L. Doolittle, *arrangements*
I. E. McDougal, *entertainment*
H. A. Cordes, *finance*
W. F. Schott, *student activities*
P. M. Klauber, *publicity*
C. J. Nevitt, *golf*
E. H. Templeton, *transportation and inspection trips*
Mrs. H. A. Cordes, *ladies*

Second AIEE Division Formed in Puerto Rico

A new geographical division of the AIEE was formed June 1, 1947, at San Juan, Puerto Rico, embracing the three eastern districts of San Juan, Humacao, and Guayama. This is the second Puerto Rican divison to be added to the New York Section during the past few months, the first having been organized on March 9, 1947 (*EE, May '47, p 501*).

The newly elected officers include Ivan Megwinoff (A '38) *chairman;* Victor Manuel Cataldo (A '37) *secretary;* F. del Valle Atiles (M '45) *treasurer.* There are a large number of former members in this area and immediate steps will be taken to build up the active membership to at least 30 in the near future.

Chairman Megwinoff, chief engineer of Megwinoff and Company, has been instrumental in carrying forward the organization of this new division of the New York Section

63d Summer General Meeting Is Fourth to Be Held in Canada

Emphasizing the international nature of the AIEE, the 63d * annual summer general meeting was held in Montreal, Province of Quebec, Canada, June 9–13 inclusive, 1947, with headquarters at the Mount Royal Hotel. Summer meetings previously held in Canada were, the 39th in Niagara Falls, Ontario, in 1922; the 47th, in Toronto, Ontario, in 1930; and the 58th in Toronto, Ontario, in 1941. The meeting dates this year were the earliest in a great many years, and were dictated to the local committee by the necessity of getting in ahead of the regular summer season in order to be assured of adequate hotel facilities. The earliness of the date resulted in some conflict with school and college schedules which prevented the attendance of some officers and members. The verified attendance of 1,451 persons, however, has been exceeded only by the 1923 meeting in Swampscott, Mass., for which the reported registration was 1,616. Attendance figures are given in further detail in the accompanying tabulation.

The formal program was made up of 13 regular technical sessions, 14 technical conference sessions, 10 administrative conferences, and some 25 committee meetings. All sessions were well attended, although the heavy program of sessions and conferences made it difficult for members to take full advantage of the generous variety of inspection trips, sight-seeing trips, and recreational activities arranged by the local committee. The program provided for the presentation and discussion of some 63 technical program papers, 43 informal conference papers, and a large number of conference topics of current interest.

As at Detroit, the heavy technical program was the subject of considerable casual comment among members and the delegates, one school of thought vigorously upholding the idea of a full and diversified program as a means of appealing to a wider range of membership interests and consequently performing a broader service, the other school of thought believing that for the summer general meetings, the technical sessions should for the most part be confined to the morning, leaving afternoons open for inspection trips, recreation, and other activities.

With the exception of five committee meetings which were held in the headquarters building of the Engineering Institute of Canada, and the annual conference of officers, delegates, and members, which was held at the Windsor Hotel, all technical sessions, conferences, and committee meetings were held at the headquarters hotel.

ENTERTAINMENT FEATURES

A generous program of entertainment activities was nicely planned and executed by the local committee to suit the varied interests of attending members and guests. As an innovation of practical quality, the committee arranged for the Normandy Roof dining room of the Mount Royal Hotel to be opened daily for a special noon luncheon exclusively for AIEE members and guests, obviating the necessity of competing with other crowded luncheon facilities. Facilities for numerous inspection trips to points of technical interest, and for visits to Montreal's many points of artistic and historic note were arranged by the local committee. The women's program included a fashion show and tea at the department store of The Eaton Company of Canada; a military whist party at the Windsor Hotel, the evening of the men's smoker; and all-day 100-mile scenic trip through the Laurentian Mountains with luncheon at the famous Alpine Inn at Sainte Marguerite-du-Lac Masson, and an all-afternoon tour of Montreal including the Botanical Garden where the women were guests of the City of Montreal for tea.

At the opening general session Monday noon, Doctor de Gaspe Beaubien (M '21, member for life) general chairman of the summer meeting committee, presided. Official welcomers to Montreal included a representative of the mayor and Doctor C. J. MacKenzie, past president of the Engineering Institute of Canada and currently president of the National Research Council of Canada. The men's smoker, held Tuesday evening, was a double-feature program, presenting in the Normandy Roof dining room a table-served buffet dinner complete with floor show and, across the hall in the neighboring ballroom, a circus variety show, ranging from Golden-Glove boxing matches to clown acts and other side show features.

Twin highlights of the general entertainment program were the dinner and dance held in the Mount Royal Hotel Thursday evening and the 2-day boat trip down the St. Lawrence which left Montreal Saturday evening. A reception for President Housley immediately preceded the banquet, which was addressed by Canada's distinguished General A. G. L. McNaughton (Honorary Member, AIEE). General McNaughton spoke on the topic, "Co-operation of Canada and the United States in the Defense of North America," presenting unofficially his own personal opinions from his point of view as present chairman of the Canadian Section of the Canada and United States Permanent Joint Board of Defense. General McNaughton's address appears elsewhere in this issue (see pages 754–7). For the Saguenay boat trip, a steamer was chartered from the Canada Steamship Company, the party leaving Victoria Pier in Montreal at 6 o'clock, Friday evening, June 13, arriving at Bagotville on the Saguenay River at about 5 o'clock, Saturday evening, where the boat remained tied up until about 1 a. m. Sunday morning. From Bagotville, the Aluminum Company of Canada served as host for a side trip to the Shipshaw power development and to the Arvida Works of the Aluminum Company of Canada. The Shipshaw development comprises two hydroelectric generating stations having a total installed capacity of 1,500,000 horsepower. The Arvida Works are rated as the largest aluminum plant in the world. Returning from Bagotville, a $3^1/_2$-hour stopover was made at Quebec City, the boat arriving back in Montreal, early Monday morning.

Other inspection trips included the radiation laboratory at McGill University in Montreal, where a 100,000,000-electron-volt cyclotron is under construction, and an afternoon trip to the Beauharnois Hydroelectric development where some 650,000 horsepower in electric energy is developed by the 13 hydroelectric units making use of the 80-foot head in the Soulanges section of the St. Lawrence River between Lake Ste. Francis and Lake Ste. Louis. Visitors were guests of the Beauharnois Light, Heat and Power Company. Quite a number took advantage of a special airplane inspection trip to the Shipshaw development Wednesday afternoon.

Recent Summer-Meeting Registration

Year	Location	District	Registration
1947	Montreal	10	1,451
1946	Detroit	5	1,351
1945	Not Held		
1944	St. Louis, Mo.	7	1,142
1943	Cleveland, Ohio	2	1,179
1942	Chicago, Ill.	5	1,173
1941	Toronto, Ont.	10	1,204
1940	Swampscott, Mass.	1	1,010
1939	San Francisco, Calif.	8	945
1938	Washington, D. C.	2	827

Analysis of Registration at 1947 Summer General Meeting, Montreal, Canada

	Districts											
Classification	1	2	3	4	5	6	7	8	9	10*	Elsewhere	Total
Members	135	152	94	37	119	11	33	14	9	203	3	810
Men guests	21	25	16	5	18		7		1	222	8	323
Women guests	42	59	31	15	37	3	16	6	6	90	1	306
Students	1	3			1	1	1			5		12
Totals	199	239	141	57	175	15	57	20	16	520	12	1,451

* District in which Montreal is situated.

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* Despite the fact that no AIEE summer meeting was held in 1919 or in 1945 the 1947 summer general meeting officially has been designated the 63d summer meeting to conform to the number of years of the Institute's existence.

GOLF TOURNAMENTS

The AIEE Mershon Trophy was won by Charles B. Oler (M'35) of the Maryland Section. The winner is assistant professor, Post-Graduate School, United States Naval Academy, Annapolis.

The present Mershon Trophy is the third in a series of trophies presented to the AIEE by Past President R. D. Mershon (F'12). This trophy is available for competition by Institute members on the basis of match play and handicap. Each winner is entitled to have his name engraved on the trophy, and also receives a suitable memento of the occasion. The trophy remains in the permanent possession of the Institute, and is kept on display in the members reception room at headquarters in the Engineering Societies Building in New York, N. Y. The two earlier trophies donated by Doctor Mershon were won permanently. With the addition of the 1947 winner, the names now appearing on the Mershon Trophy are as follows:

1947	C. B. Oler (Maryland Section)
1946	Tomlinson Fort (Pittsburgh Section)
1942	H. G. Schultz (Chicago Section)
1941	D. S. MacCorkle (New York Section)
1940	H. A. McCrea (Boston Section)
1939	F. R. George (San Francisco Section)
1938	T. O. Rudd (New York Section)
1937	C. H. Teskey (Cleveland Section)
1936	Carl E. Johnson (Los Angeles Section)

The Lee Trophy, presented to the Institute in 1933 by former Past President W. S. Lee, has been available for competition among Institute members on the basis of lowest net score for 36 holes, the trophy to be won twice by the same player for permanent possession. At Montreal, G. R. Canning (M'45) of the Cleveland Section, protection engineer for the Ohio Bell Telephone Company, won the Lee Trophy, and by virtue of having won it at the competition in 1933 in Cleveland, becomes its permanent possessor. The names on the trophy now will be

1947	G. R. Canning (Cleveland Section)
1946	K. M. Smith (Chicago Section)
1941	T. H. Hogg (Toronto Section)
1940	H. E. Wulfing (Chicago Section)
1939	W. G. B. Euler (San Francisco Section)
1938	T. A. O'Halloran (Washington Section)
1937	G. A. Kositzky (Cleveland Section)
1936	H. S. Warren (Los Angeles Section)
1935	A. H. Sweetnam (Boston Section)
1934	F. M. Craft (Georgia Section)
1933	G. R. Canning (Cleveland Section)
1932	C. H. Teskey (Cleveland Section)

The Montreal tournaments were played at the Whitlock Golf Club located at Hudson on the Montreal–Ottawa highway. The local committee also arranged for playing privileges for AIEE members at the following several clubs, Royal Montreal Golf Club, 10 miles west of Montreal; Elmridge Gold Club at Dorval; Country Club at Ste. Lambert, 4 miles south of Montreal on the south shore of the St. Lawrence River; Summerlea Golf Club at Lachine, on the main highway 9 miles west of Montreal; Rosemere Golf Club, 12 miles north of Montreal.

COMMITTEES

The smooth-functioning quality of the summer meeting in Montreal, and the extent and variety of its technical and social program, bore evidence of the hard work done over a long advanced period by the volunteer group which comprised the various local committees.

General Committee

Doctor de Gaspe Beaubien, *chairman;* H. W. Haberl, *vice-chairman;* G. H. Gillett, *secretary-treasurer;* F. L. Lawton, vice-president of AIEE for Canada District 10; W. R. Simmons, chairman Montreal Section; M. C. Thurling, secretary Montreal Section; D. M. Farnham, secretary District 10; R. M. Pendergast, Ottawa Subsection representative; D. Anderson, Engineering Institute of Canada representative; J. A. Beauchemin, EIC representative; J. M. Crawford, EIC representative.

Hospitality Committee

P. W. Howlett and C. E. Gelinas, *cochairman;* L. Scharry; F. N. Beattie; G. G. Kinnear; P. D. Rossiter.

Meetings and Papers Committee

W. R. Way, *chairman;* C. L. Roach; D. J. McDonald; J. L. Davison; L. K. Hart; T. O. Evans.

Sports Committee

J. L. Clarke, *chairman;* H. Tincombe; C. A. Barber; N. Wright; R. L. Mooney; N. Morgan; W. H. Cam; R. N. Coke; A. D. Ross.

Hotels Committee

R. Hobner, *chairman;* G. Griffiths; A. G. Moore; A. Malkin.

Publicity Committee

W. E. Davison; J. A. Smith; W. Sharples; H. L. Mahaffy; E. Stanger; A. C. Abbott.

Inspection Trips Committee

A. W. Howard, *chairman;* J. D. Madill; Doctor J. S. Foster; G. Kingsmill; H. L. Hurdle; M. C. Archibald.

Transportation Committee

J. D. Sylvester, *chairman;* R. J. Brydges; D. F. Haney; H. A. McColeman.

Finance Committee

L. E. Potvin, *honorary treasurer;* C. C. Parkes, *secretary;* H. W. Haberl; D. Anderson; F. Krug; W. R. Simmons; J. Kazakoff.

Registration Committee

J. R. Auld and E. Van Koughnet, *cochairmen;* W. O. Sorby; R. R. Gregory; S. E. File; W. E. Walker; B. H. Johnston.

Women's Hospitality Committee

H. H. Remine, *chairman;* Mrs. H. H. Remine, *vice-chairman.*

Hospitality Committee

Mrs. D. M. Farnham and Mrs. D. Anderson, *cochairmen;* Mrs. J. A. Fletcher; Mrs. G. Kirlin; Mrs. F. C. Galer; Mrs. A. S. Runciman; Mrs. R. N. Coke; Mrs. E. A. McKeegan; Mrs. F. Krug; Mrs. H. Milliken.

Saguenay Boat Trip Committee

G. Kirlin, *chairman;* A. C. Abbott; R. Mooney; G. Millican.

Smoker Committee

C. A. Laverty, *chairman;* N. Morgan; G. Finch; F. Gaylor; J. Merritt.

Students Committee

Professor H. Gaudefroy; Professor G. A. Wallace; Professor W. H. Shippel; Professor Rene Dupuis; Professor J. Lawrence.

Sightseeing Tour Committee

Mrs. C. E. Gelinas, *chairman;* Mrs. de Gaspe Beaubien; Mrs. J. A. Beauchemin.

Whist Party Committee

Mrs. G. H. Gillett, *chairman;* Mrs. W. R. Simmons; Mrs. A. L. Hough; Mrs. A. C. Abbott; Mrs. C. Laverty.

Fashion Show Committee

Mrs. M. C. Thurling and Mrs. J. A. Beauchemin, *cochairman;* Mrs. J. R. Auld; Mrs. H. W. Biskeborn; Mrs. E. A. McKeegan; Mrs. A. Duffesson; Mrs. B. Le Bel; Mrs. P. E. Poitras.

Laurentian Tour Committee

Mrs. H. W. Haberl, *chairman;* Mrs. P. W. Howlett; Mrs. T. O. Evans.

Forum for Officers, Delegates, Members Provided at Three Conferences

The annual conference of officers, delegates, and members for 1947 was held in the Windsor Hotel, Montreal, Canada, as a part of the program of the summer general meeting of the Institute held in that city, June 9–13, 1947. This year's conference actually was a series of correlated conferences extending through Monday, Tuesday, and Wednesday afternoons.

1. A triple conference Monday afternoon, at the Mount Royal Hotel, meeting in three parallel groups, one representing the larger Sections, one representing the Sections of intermediate size, and one representing the smaller Sections; devoted to topics concerning Section operation and management.

2. The main conference, embracing all groups, held Tuesday afternoon at the Windsor Hotel, built around the theme "The Institute of Tomorrow," for the presentation of brief reports on important phases of AIEE activities covering the year's progress and an outline of plans and possibilities for the future.

3. A conference concerning "Technical Group Activities in the Sections," held Wednesday afternoon at the Mount Royal Hotel, which drew attendance from representatives of Sections of all sizes.

Attendance at all of the sessions included many officers and members other than the responsible delegates. All of the ten Districts were represented officially by District secretaries, the vice-presidents from all but the Great Lakes District were present, and Student Branch counselor-delegates attended from all but the Pacific and Canada Districts. Official delegates also were present from 74 of the 78 Sections officially listed as active at the time of the summer general meeting. The Sections not represented officially were Mansfield, Muscle Shoals, Rock River Valley, and South Carolina.

SOCIAL PERIOD EFFECTIVE

A most effective preliminary to the series of conferences was a wholly informal "Delegates Get-Together," with no program whatever, convenient accommodation for which was provided Monday forenoon in one of the small assembly rooms adjacent to the registration area. This innovation in the program of meetings and conferences was sponsored by the Sections committee for the purpose of providing convenient opportunity for Institute officers, committee members, Section delegates, and other interested members to renew old acquaintances, make new ones, and exchange ideas concerning Institute affairs.

Acquaintanceships formed during this informal social period were valuable throughout the general meeting, and especially aided the various conferences on Institute affairs, greatly facilitating a closer and broader understanding of the aims and objectives of the Institute and the ways in which these relate to the expanding activities of the Sections and their opportunities for effective service.

Main Conference

The main conference of officers, delegates, and members was held Tuesday afternoon, June 10, in the York Room of the Windsor Hotel, with R. M. Pfalzgraff (M '41) of the Philadelphia Section, presiding, and A. C. Muir (M '39) of the Philadelphia Section acting as secretary. In opening the meeting, Chairman Pfalzgraff drew special attention to the international flavor represented by the holding of the 1947 conference in Canada, with a strong delegation present from the Mexico City Section which will be host to the 1948 summer general meeting and related conferences.

AIEE Vice-President F. L. Lawton (M '36) spoke on behalf of District 10 in welcoming the conference to Montreal. Mr. Lawton reminded his audience that, in a population of some 13,000,000, Canada has approximately 5,000 electrical engineers of which some 960 are members of the AIEE; and an additional 80 potential electrical engineers are Student members. The first AIEE Section in Canada was organized in Toronto in December 1903; in August 1911 a Section was formed in Vancouver, British Columbia; and in April 1943 the Montreal section was activated in the Province of Quebec. AIEE Student Branches have been active in Canada, at the University of British Columbia since 1930, at the University of Alberta at Edmonton since 1939, and at the University of Toronto since 1946.

Concerning Subsection activity in Canada, Vice-President Lawton noted that the oldest Subsection was formed at Hamilton, Ontario, in 1943, followed by a Subsection in Ottawa in 1944, and in Niagara in 1946; and that an inaugural meeting of the St. Maurice Valley Subsection of the Montreal Section was held May 29, 1947. With 20 per cent of Canada's electrical engineers already active in AIEE, and with rapidly growing interest evinced by the activation of Subsection groups, Mr. Lawton predicted that "within a few years there will be several new Sections operating in Canada."

President J. Elmer Housley (F '43) described briefly his experiences in visiting AIEE Sections in the United States, Canada, and Mexico, during the administrative year now drawn to a close. He paid tribute to the Sections committee for the effective manner in which AIEE Section activities have expanded so markedly, and challenged the "Section of tomorrow" to give local attention, not only to matters of technical interest, but to other matters of professional concern to the electrical engineer.

AMERICAN ENGINEERING ASSOCIATION

President-Elect B. D. Hull (F '39) spoke on the topic "An American Engineering Association." Mr. Hull for the past two years has been a member of the professional activities subcommittee of the AIEE committee on planning and co-ordination, and he centered his remarks around the report of that committee as published in the recent May issue of *ELECTRICAL ENGINEERING*. Concerning the matter of organization in the engineering profession, Mr. Hull said:

"World War II has emphasized as never before the importance of the engineer in the activities of the nation, and the fact that he must assume that leadership in public and private affairs which this importance implies. However, he is beset by growing problems affecting his professional life which he cannot meet as an individual or through the local and national societies now available. . . . I believe that all of us feel the urgency of the need for some organization better equipped to cope with these developments. There remains the very difficult problem of finding the right kind of an organization. . . . I wish to call attention to a few considerations which I believe are fundamental to any form of inclusive organization.

"Such an organization must preserve intact, and allow for the complete freedom of development of, the existing technical societies as originally conceived. Despite some duplication and overlapping, these societies are carrying out their primary purpose of fostering and spreading scientific and engineering knowledge with reasonable effectiveness. Any interference with these basic functions on the part of a national organization would serve no useful purpose. However, the development of their technical work, by the large number of national societies, has resulted in a great deal of duplication and overlapping of efforts which 'an American Engineering Association' well might strive to eliminate. There are many technical committees maintained by two or more of the societies, performing essentially the same work which could be co-ordinated" as also could "technical activities requiring co-operation of two or more societies. . . . Further, while preserving all of their technical activities unimpaired, it will be necessary for the national societies to surrender to the national body some of their nontechnical activities. These are activities of long standing, with entrenched privileges and prerogatives which will be difficult to give up. This represents the hardest part of the job. But, unless it is done, that co-operation, that co-ordination of effort, that unity of action, we must have to accomplish the purpose, will fail. It will be a painful operation, but I believe our survey of the membership opinion has given proof that the AIEE members are ready to do this. . . . I am sure that others will be, also.

"Another point I wish to make, and which the proposed setup recognizes, is that any organization of the kind which we have in mind must begin at the bottom and work up, and not at the top. . . . It must be based on individual membership. Further, such individual members must be associated locally in a strong society or council. The organization will succeed or fail depending entirely on the strength of the local bodies. From them, a rather simple line of representation can be established through regional units to the national body; or directly, if that is found to be more effective. . . .

"Finally, a set of uniform grades and qualifications for membership should be adopted by all participating societies, and apply also to individual members not belonging to any of the participating societies. The committee report in the May issue of *ELECTRICAL ENGINEERING* outlines such qualifications. . . .

". . . I hope that during the next administration year, we may press forward on two points. First, we must arrive at a type of organization which will reflect the will of the majority of our membership. . . . Second, we must enlist the active co-operation of other national societies. . . . I hope that before the Institute year closes, we can have created such enthusiasm for a new organization that the technical societies, the Engineers' Council for Professional Development, the National Society of Professional Engineers, and others that qualify, will be ready to appoint representatives to what we might call a constitutional convention to draw up a constitution and bylaws."

AIEE PUBLICATION SERVICES

Supplementing the project report made to the 1946 conference of officers, delegates, and members during the summer general meeting in Detroit, G. R. Henninger (F '43) AIEE editor, summarized the progress made to date in putting into effect the enlarged publication program authorized by the AIEE board of directors, October 23, 1946. In general, this information, represented a digest of the report of the publications committee as included in the report of the board of directors (*EE, July '47, pp 714–36*).

Commenting in further detail about *ELECTRICAL ENGINEERING*, Editor Henninger asserted that, since the change in publication policy became effective with the January 1947 issue, the monthly publication has carried to every member and Student member of the Institute more than 616 pages of text matter including the following different classes of material:

1. 113 pages carrying a condensation, or essential substance, of some 34 technical program papers.
2. 287 pages carrying 71 general articles drawn from AIEE and other sources on subjects of current importance to electrical engineers.
3. 120 pages carrying 282 separate items reflecting AIEE activities, including comprehensive reports of District and general meetings.
4. 48 pages carrying 252 news items from sources other than AIEE on activities related to engineering.
5. 30 pages carrying 69 "Letters to the Editor," an open forum.
6. 28 pages carrying 353 personal items on the activities of individual members of the Institute.

7. The average 1947 issue of *ELECTRICAL ENGINEERING* has contained 106 editorial pages carrying 177 separate items of some current interest.

The editor also apprised the meeting that he was widely circulating a questionnaire covering the foregoing listed current content of *ELECTRICAL ENGINEERING*, and urged all members attending the convention to make use of that questionnaire as a convenient medium of constructive criticism concerning the current AIEE publication policy.

With reference to *PROCEEDINGS*, the editor reported that all technical program papers and discussions from the 1947 winter general meeting and from the recent North Eastern District meeting, and some of the papers from the current summer general meeting, had been processed through the editorial department and were in the hands of the printer. He reported that printing plant congestion and other factors not subject to satisfactory control were resulting in delays ranging up to six weeks or more in the actual printing and distribution of this material; at the time of the report in Montreal, only about half the *PROCEEDINGS* involved actually had been mailed. With reference to the first *PROCEEDINGS* order coupon, which was published in the February issue of *ELECTRICAL ENGINEERING*, the following brief preliminary statistics had been prepared:

Number of coupons received up to June 1—1,996; 23 per cent of these called for less than 10 *PROCEEDINGS*, 66 per cent called for at least 10, 11 per cent called for more than 10; the smallest number ordered was 3, the highest numbered on any one coupon was 98 (100 per cent). Total number of *PROCEEDINGS* sections ordered, 21,063, averaging between 10 to 11 per coupon.

The editor announced that the second *PROCEEDINGS* order coupon, covering a consolidated listing of the technical program papers for the North Eastern District meeting and for the summer general meeting in Montreal, was published in the June issue of *ELECTRICAL ENGINEERING*, and that copies of that coupon already were coming in heavily.

TRANSFERS—A CONTINUING PROGRAM

Speaking for Chairman D. E. Moat (M '39) of the AIEE committee on transfers, M. J. McHenry (M '20) of Toronto, vice-chairman of the committee, reported:

"The transfers committee, in its operation during the year, realized that many Sections in recent years have not been taking the interest they should in encouraging their eligible members to apply for higher grades of membership. Believing that the lack of a uniform guide was the primary reason for the apparent disinterest, the committee on transfers concentrated its efforts this year on the preparation of a general guide supplemented by a specific set of suggestions to the local Sections:

1. Each Section should have a grade transfer committee as a standing committee.

2. Each local committee should be sufficiently large to represent fully the professional groups and industries within the area.

3. Each local committee should be a continuing committee operating throughout the calendar year.

4. Each local committee should be composed of the best known, highest respected, and most representative members in the Section.

5. Any candidate for transfer should be considered by a group of the local committee having grades no lower than the grade being considered for the candidate.

". . . the committee has been interested in noting the methods which some of the Sections have adopted in tackling the problem of transfers. One Section has prepared a memorandum to its local membership to answer what is perhaps the most fundamental question: 'Why a membership transfers committee?' The Sections committee answer to this question is worth quoting:

Our existence as a committee is based on the truism that, if AIEE membership grades are to have the meaning for which they are intended, every person affiliated with the Institute should have the highest grade for which he is qualified. The higher grades should be, and are, a badge of recognition and achievement. . . .

"Along the same line, the transfers committee rendered a report to the Sections in December 1946, from which the following is quoted:

The penalty of not having a committee on transfers is that many worthy individuals never may become Fellows, and some never even become Members. A situation of this nature, if allowed to continue, will weaken a Section. Why should a nonmember join the Institute when prominent and clearly qualified members of the Institute are still in the lower membership grades? The Section owes it to its members and to the Institute as a whole to have a well-organized committee of transfers as a standing and continuing committee.

"The committee on transfers of the Institute cannot recommend effectively to the Sections that they establish standing and continuing committees to carry out this important work when it, itself, is not a standing committee. It is recommended, therefore, that the committee on transfers of the Institute be made a standing committee, that it be made a continuing committee by the replacement of not more than half of its members each year, and that it include the chairmen of the committees on transfers of the Sections as ex-officio members."

Upon the conclusion of Mr. McHenry's report, retiring Chairman J. H. Pilkington (M '34) of the New York Section, offered the following proposal:

"In order to enable the committee on transfers to function more effectively, and on a continuing basis, and to enable several Sections each to establish a local committee on transfers, likewise on a continuing basis, I move that Section 65 of the Institute's bylaws under the heading 'General Committees' be amended to include the 'committee on transfers' as a standing committee.

"Furthermore, I move that a new section be inserted and properly located in the bylaws, which will define the organization and the duties of the 'committee on transfers,' including the chairmen of Section committees on transfers as ex-officio members of the AIEE committee on transfers."

Unanimously favorable action on this proposal was sent to the board of directors for consideration and appropriate action.

Section Activities Set New Record

Chairman G. W. Bower (M '40) chairman of the AIEE Sections committee, reported that Section activities for 1946–47 have set a new record in Institute history with a total of 1,333 Section meetings accounting for a total attendance slightly in excess of 155,600; the corresponding figures for 1945–46 were 1,187 meetings for a total attendance slightly in excess of 116,000.

For additional data pertaining to Section activities this past year, Chairman Bower referred to the report of the Sections committee as included in the current report to the board of directors (*EE, July '47, pp 714–36*) and urged all members and especially Section and District officers to read the report.

TECHNICAL GROUPS

"The development of technical groups within the Sections continued to be one of the most important activities of the Sections committee," stated Mr. Bower. "The importance of this activity is being recognized by the provision for a separate conference at this summer general meeting and for technical group activities in the Section . . . last year at Detroit, a total of 82 such technical groups were reported to be in operation . . . 123 are reported in operation as of June 1947. These results amply have justified the Sections committees optimistic attitude on this very important activity. Technical group operation has made it possible for the Sections to have the more technical subjects covered in the smaller group meetings, so that the main Section meeting may be devoted to general technical subjects which will appeal to the entire membership. By this means, the Sections attain a flexible organization which satisfactorily provides for the needs of the diversified membership in the growing number of new and specialized fields of electrical engineering.

"Technical group activity in the Sections also has opened up a new field of co-operation within the Institute. The Sections committee has been exploring the possibilities of co-operation between the Section technical groups and the corresponding Institute technical committees. Definite suggestions on this co-operative effort have been sent out during the past year to the chairmen of all Sections, as well as to the chairmen of all Institute technical committees. In suggesting this new field of co-operative activity, the Sections committee fully realizes that there is no direct connection between the Section technical groups and the Institute technical committees. However, there is a field of 2-way co-operation within the Institute which, if properly developed, will be sure to result in very material benefits to the Institute. Sections operating technical groups are urged to follow up this co-operative activity during the forthcoming year.

SUBSECTIONS

"The development of Subsections also has continued to be a very important activity. . . ." Mr. Bower reported that a total of some 33 Subsections now are in operation as compared with 26 a year ago.

LOCAL COUNCILS

He added: "Co-operation with other societies at the local Section level is being covered very satisfactorily by the local councils of engineering and technical societies. During the year, the Sections committee sent considerable information to five AIEE Sections which were active in forming new councils in their areas. These local councils have been organized in 45 metropolitan areas. . . . They provide for the need in many metropolitan areas for organized co-operation of all the engineering societies in the area, on a local basis, and the AIEE Sections have been very active in the organization and operation of these local councils. This extensive development of local Councils should be an indication of the need of a co-operative organization at the national level. Mr. Hull elaborated on that subject (see preceding paragraphs). These local councils should be given much consideration in the development of a national engineering association."

Mr. Bower also mentioned that Section-Branch activity in co-operation with AIEE committee on Student Branches had been continued throughout the year; that recommendations had been made to the board of directors for the revision of the rules governing prize-paper competitions; that three new Sections had become operative on May 1—the Arrowhead Section at Duluth, Minn.; the Little Rock Section in Arkansas; and the Rock River Valley Section at Rockford, Ill. He reported also that a new division, of the New York Section, had been activated at Mayaguez, and was the first to start operation outside of the continental United States. He emphasized "that the work of the Section committee has not been a 1-man job." Every member of the committee contributed extensively either in developing or in promoting this program. Much credit for the success of our program is due to the fact that each member of the committee made a substantial contribution to the work of the committee. Looking to the future, Mr. Bower forecast:

The AIEE Section of Tomorrow

". . . The Section of Tomorrow will be an alert and flexible organization, capable of expanding its activities to meet the ever-increasing scope and growing demand of the electrical engineering profession and to provide for the diversified interests of all its members. There will be an active fellowship committee which will bring down the formal atmosphere which exists in too many of the present-day meetings, and which will make new members, as well as the older members, feel more at home when attending meetings. Our attention will be given to social meetings and to inspection trips. Occasional meetings will be held at some of the larger industrial plants, and some of the inspection trips will be combined with social events.

"The officers of the Section of Tomorrow will be more conscious of the importance of balanced Section operations which will provide all the activities necessary, to retain the older members as well as to attract new members. These officers will give more time to creative work and to the co-ordination of the activities of their Sections. This will mean that much of the work of the Section will be performed by operating committees. The resulting increase in operating committees will provide the opportunity for more members to work actively for the Section, which in turn will create additional interest. These results are accumulative.

"The Section of Tomorrow will operate from two to ten technical groups. It will be an active member of the local engineering council. It will conduct educational courses and lectures for its members and other engineers in the community, as a supplement to the work of the educational institutions in its area. Some of these educational courses even may be in co-operation with the educational institutions.

"The Section of Tomorrow will provide organized meetings in all centers of population in its area a considerable distance from the regular Section meeting place. These Subsections will conduct such activities as are necessary to provide for the interest of the members residing in that local area. Many of these Subsections will be small, and will follow the program and activities of the parent Section. The Section of Tomorrow will co-operate very closely with the Student Branches in its area. It will have representatives attending many of the Student Branch meetings, and officers of the Branch will be invited to attend some of the meetings of the governing body of the Section. Many of the items on the plan of Section–Branch co-operation will be followed, with the result that more students will become interested in AIEE during their student life. This will result in more students transferring to active membership upon graduation. . . .

"Prize-paper competition will be conducted each year as a regular part of Section activities. This will result in more members of the Institute, and especially the younger members, acquiring the habit of writing technical papers. The idea of safety, from the standpoint of the engineer, will be included in many of the technical meetings. Last, but not least, it will record the history of the Section.

"The Section of Tomorrow will show keen interest in the operation of the Institute. Since the Section of Tomorrow will represent a large portion of Institute activities, so far as the average member of the Institute is concerned, it is only natural that this interest should find suitable expression in the management of the Institute. . . . Opportunities for expansion of Section activities are unlimited. It should be the goal of every Section chairman to see to it that during the coming year his Section becomes one of the Sections of Tomorrow."

"The District of Tomorrow"

Carrying out the conference theme, AIEE Secretary H. H. Henline (F '43) spoke on the assigned topic, "The District of Tomorrow," pointing out that, because of the close relationship between the Sections and their Districts, many of the ideas given in the foregoing paragraphs by Mr. Bower concerning the Sections of Tomorrow might be applied equally well to the District of Tomorrow. Mr. Henline briefly summarized the history of the development of AIEE District activities:

"The plan for establishing ten Districts each with a vice-president went into effect in 1920. The purposes as stated at that time were 'first, to give the membership closer contact with the Institute officers; second, to develop greater interest among the younger members; third, to stimulate Section activities.' These basic objectives still apply, but if we were writing them now I am sure that we would add a fourth: the stimulation of Branch activities. Although not originally stated, the stimulation of Branch activities has been an important function of our Sections and Districts since 1920. Since 1920 also, numerous provisions have been added to the bylaws covering District activities including provisions for the organization and operation of District executive committees; for District co-ordinating committees; for the holding of District meetings. . . . The District vice-presidents make recommendations for the appointment of Student Branch counselors . . . for more than 20 years, traveling expenses of District representatives to official District and national conferences have been provided. . . . The Districts have taken a large part in arranging for Sections visits by the president and others. . . . Last year at the summer meeting, there was adopted by the board a definite arrangement providing in some detail for visits to Sections by national officers . . . at the same time, the definite responsibility for these visits was placed directly on the District vice-president . . . also, the Districts have had a definite part in the work of developing the membership of the Institute . . . the District organizations deserve a great deal of credit for many of the developments in Institute activities, because many recommendations stemming from the District have become the practice for the Institute as a whole."

Looking into the future, to the "District of Tomorrow", Mr. Henline suggested that perhaps the principal opportunity for the further development for District activities lay in the direction of better co-ordination of Section and Branch visits, more and better District meetings, and of the stimulation of more effective Section and Branch meetings. In reference to the first of these topics, Mr. Henline said, "it will help if the Sections and Branches have some kind of definite plan to be followed in connection with these visits . . . a word of caution, however, is desirable, because we have found for many years, that in some cases too much dependence is placed upon visiting figures, and the Sections and Branches which follow that practice get into the habit of doing very little themselves, and merely come to listen to someone from 'outside.' It seems to many of us that the success of the Sections and Branches depends entirely upon what their own members put into their activities, and not on what can be brought in from outside. . . ."

"The second opportunity for expansion, I believe, is in District meetings. We have had a great many of these, and there are opportunities, I am sure, for an increasing number. The program for such meetings should be based more largely upon problems in the District of contemporary local interest. These meetings were established for that purpose. The various Districts differ in many respects, and there is the opportunity for each District to adapt its District meeting best to suit its own conditions, its own technical or other developments, and its own interests. Efforts should be made to encourage broader local participation in such District meetings.

"Third, a District can do much more, I believe, to stimulate effective Section and Branch activities—especially in those places where such stimulation is needed. In spite of Mr. Bower's very favorable report, there remain many opportunities for an increase in activity. The Subsections and technical groups that Mr. Bower has discussed might be increased greatly if all Sections really get going. Also, as he has indicated, the Sections have a great opportunity for the joint discussion of their own problems in their own Districts, and if the Districts adopt a definite practice of activity discussing Section operation and management in a thoroughgoing fashion, many Sections will be improved.

"Also each District has a definite place in AIEE membership activities. Each District holds a vice-chairmanship on the national membership committee, and the membership chairman of each Section is ex officio a member of the national membership committee, thus providing a definitely interrelated organizational fillip. The actual District membership activities are carried on largely through the Sections; in fact, the whole membership activity of the Institute is based largely upon the work of the Section membership committees. Thus, the most important basis for membership activities lies in the activities program of the individual Sections. If the Sections will expand their activities, building up active interests and wide participation among their members, the interests inevitably will spread to many eligible individuals who are not members and who thus might be stimulated to seek the advantages of membership. . . ."

Secretary Henline warned against overaggressive membership campaigns reminding that: "The board of directors, in the middle 1920's found some grounds for criticizing membership campaigns at that time because they were too active and were bringing in men who had little real interest in AIEE and not very good qualifications for membership; consequently the board decided that there should be no more high pressure membership campaigns . . . since that time membership activities have been on the basis of developing in qualified prospective members an active interest and a real desire to come into the Institute, rather than on the basis of going out and bringing in anyone who could sign an application."

Mr. Henline reminded his audience that the Institute is a wholly mutual organization in which the beneficial returns to the individual and to the profession at large are not catalogued in services to be bought by membership dues or subscription fees, but are directly dependent upon the time, interest, and participation contributed by individual members in local Section and Branch activities, in District activities, in national activities, and throughout the entire functional structure of the Institute: "The Institute . . . is a voluntary organization . . . to provide maximum opportunity for the participation of its members in its activities; . . . these activities are determined by the interest of the members . . . and can be successful only if they are on a basis that will arouse and maintain interest among the members who are qualified to participate. . . ."

Membership Activities—Future Possibilities

"No activity of the Institute is related so closely to the Sections as is membership activity, as membership must come through Section levels," so stated Tomlinson Fort (M'35), chairman of the Pittsburgh Section, of the AIEE membership committee in speaking on the assigned topic, "Section Membership Activities—and Its Future Possibilities." Mr. Fort gave full credit to the Section membership committees for the present all-time high level of AIEE membership and for the continuing heavy inflow of membership applications. As to prospects for future members, Mr. Fort reported that his committee was basing its plans upon three general classifications of prospects:

1. Electrical engineering students who are prospective Student members.
2. Engineering graduates who are Student members and who should transfer upon graduation to Associate grade.
3. Practicing electrical engineers who are eligible for membership but who are not members.

Chairman Fort reported that the national membership committee, when organized for the 1946–47 administrative year, had decided to decentralize its operation "to have membership activity at the grass-root level"; also, to embark upon a 2-year program of developing a 3-point plan appropriately related to the three categories of prospective members listed. Mr. Fort added: ". . . we have the job at least half accomplished. Our first assignment was to develop a plan to sell student memberships to electrical engineering students in our colleges and universities. In developing this plan, we have worked closely with the AIEE committee on Student Branches. We believe that one of the best ways to sell an electrical engineering student on the advantages of joining an AIEE Student Branch is to have a successful member of the electrical engineering profession give him a specific invitation and describe to him the benefits of AIEE membership. Accordingly, we have developed a talk for Student Branches, and it is hoped that this talk may be presented before every Student Branch shortly after the opening of school this coming fall, so that each qualified electrical engineering student thus will receive a direct invitation from the AIEE to become one of us. Plans are being worked out accordingly with the counselors of the various Student Branches.

"A subcommittee of the membership committee is working on the matter of stimulating the transfer of Student members to Associate grades. Some members of this subcommittee are in favor of an automatic transfer, but this would involve changes in the constitution and bylaws and may not be a practical answer. . . . The real key to this problem probably will be increased followup by Section membership committees on new engineering graduates. The third part of our program is to develop plans for Section membership committees to follow up more actively on qualified membership prospects . . . this phase of our plan will be developed in the next year.

"The Section membership committee can be effective only when the committee actually has something of real value to offer to prospective members. The best thing to offer a prospective member is participation in an active Section program. . . . Second, . . . is the necessity for having strong membership committees . . . The membership committee of each Section is one which can be large and which should be headed by a very active member who is fully familiar with AIEE affairs. . . . I should like to feel that the development of the membership of our Institute is not just the responsibility of the membership committees, but that every member of the Institute is an ex-officio membership committee man. By active participation in the Institute's affairs, and a continuous stimulation of interest in Institute matters by each of us, we can develop fully our membership possibilities along natural lines rather than along lines of artificial stimulation."

Institute Finances

Speaking on the assigned topic, "Institute Finance and Its Relation to the Section of Tomorrow," D. A. Quarles (F'41) of the New York Section, chairman of the AIEE finance committee, expressed some concern over the fact that appropriations for AIEE activities have grown more rapidly than has the Institute's income; that the expenditures committee for the appropriation year

1946–47 might, on the basis of current figures, exceed the year's income by some $40,000. Stated in another way, and extending into the future his curves for recent years, Mr. Quarles reported that unless the program and/or the economic situation changes materially in the meantime, the Institute's total expenses per member by 1950 would amount to $27.50 as compared with a gross income of $25.00 per member; that "by 1955, it would appear that we would be spending about $5 per member more than we can expect to receive of total gross income per member on the basis of our present way of collecting from the membership. . . . Quite possibly the thing to do is to face the situation squarely and say that we should increase the membership dues. However, that is an important decision, and one which should not be taken unless and until each activity of the Institute has been examined carefully and it has been determined that what the Institute is doing and what the Institute is spending are such that the membership would prefer to pay more dues to continue on the present scale of expanding activities and services of the Institute."

As items of major expense and of especial significance in the Institute's present rate of growth and organizational expansion, Mr. Quarles mentioned the formula for increased appropriation adopted last year at the instigation of the Sections committee. Also related to Section and Subsection activities is the present recommendations of a special prize awards committee to establish a new category of Section-paper prizes to be paid for out of the national budget rather than out of the local Section budget.

Mr. Quarles urged upon the delegates a full recognition of the mutual responsibilities involved in the matter of Institute finances, and urgently recommended "that it is incumbent upon each Section to organize and control its finances, perhaps by appointing a finance committee; . . . but in any event, by recognizing that sooner or later we are going to have to be talking to the membership about increased dues, and in that connection we are going to have to learn if it is in fact desirable to continue to enlarge our activities and our expenditures."

Education Courses Recommended

Speaking to the assigned topic, "Education Courses Conducted by the Section of Tomorrow," J. G. Tarboux (F'43) of the Ithaca Section, chairman of the AIEE committee on education, recommended that AIEE local Sections actively develop education courses on subject matter appropriately related to local engineering or industrial problems and local membership interests.

He said:

"'Some concern has been expressed by a few persons about the undesirability of the Institute's undertaking an educational program because it might be in competition with near-by educational institutions. The truth of the matter is that there need not bea ny such competition. Our large industrial concern: have found it necessary to develop rather expensive educational programs; these are not competitive with local educational institutions During the war, the Government-sponsored Engineering, Science, Management War Training Program flourished, and many persons benefited by class work design for self-improvement.

"AIEE Sections which are located in large industrial centers have a real opportunity to serve their membership by acting as sponsors for educational lectures and technical discussion groups. Courses should not be limited to technical subject matter, but should cover any subject of interest to a group of members. Each lecture series, should be 'tailor-made' to the group's desire . . . the leader of such a course must possess something more than a mere knowledge of the subject; he must above all be an interesting speaker . . . ."

Section–Branch Co-operation

In discussing "Section–Branch Co-operation—Essential to the Institute of Tomorrow," R. G. Porter (F'44) of the Boston Section, member of the AIEE Sections committee, urged all Sections to make it a specific project to establish and maintain a closer working relationship with the Student Branches within its territory. He urged the establishment in each Section of a special committee on student activities, the membership of which would include the counselors of all Branches within the Section territory. Professor Porter said in part:

". . . enrolled Students, individually or as a Branch group, should receive the regular meeting notices of the Section, and be made welcome at Section meetings; a designated member of the Section student activities committee should be assigned to attend each meeting of the Branch, as it is a great stimulation to the Branch to have a recognized engineer meet with them; each Section officer should visit at least one meeting of each Branch in his Section territory . . . the Section should sponsor a meeting for the presentation of student-prize competition papers; if there are several Branches in the Section, a local student convention would stimulate great interest in student papers; the Sections student activity committee should organize a definite system for following up on Student members for guidance and assistance as after they graduate from school into their initial engineering posts . . . the Student Branch chairmen should be invited to attend meetings of the Section executive committee . . . thus the Section of Tomorrow will be of service to the students, making for a better Section–Branch field of activity."

"The Institute of Tomorrow"

Everett S. Lee (F'30) of the Schenectady Section, past AIEE director and vice-president, wove the key thoughts presented by the several previous speakers into the over-all pattern of his assigned topic, "The Institute of Tomorrow." Mr. Lee said in part:

"This has been a year of superlatives. We have had the largest District meeting since 1927; our technical activities are at the highest level in Institute history; we have had the largest number of sessions that have been held at any one AIEE meeting; we now have ten new technical committees to complete the coverage of the field of electrical engineering interest of our Institute; we have added the Midwest general meeting; we have extended our Section activities to Puerto Rico, and have under consideration Hawaii and other points west; we have a new publications policy to take care of the bursting bundle of technical contributions and to serve better the diversified interests of our members; we have a new technical program organization under study; we have a new and extended program for the engineering profession brought about by members of this Institute, working toward greater professional activities and more human relations contact with other engineers; our membership is above 27,000 and the membership participation in Section meetings this year was numbered at 155,649—we have to go back only to 1942 to find the participation just one half of this figure; on the part of our Student members, the Student Branch meeting participation is up to 40,669, which brings us back to the 1942–43 levels and eliminates the depression we had in the intervening war years.

"The reason for the greatness of our Institute lies in the participation of the individual members in our various Sections . . .," said Mr. Lee, adding "I have always said that the Sections are the Institute . . . and now I add that the Institute has established the profession . . . look at the Institute and see its manyfold activities, and its membership, and what its members are doing for the service of mankind, and there you will find a definition and a picture of the establishment of a profession. . . . It is strong and it is powerful. It is the largest of all the engineering professions, and it has had the leadership to bring it where it is today. And the price of its being where it is today means that that leadership must be exercised as we continue, not only to strengthen the electrical engineering profession and to make it more prominent, but also to strengthen the engineering profession and make it more prominent.

"I think that this is one of the greatest problems of the future, but we certainly have been making a great start on it in these last three years. To a certain extent it has been forced upon us; to a greater extent, a reason lies in the urge on the part of the engineer to bring a greater consciousness of the service of the engineer. I think this is particularly true of the younger engineers who often have felt that the engineering profession has not been established on such a basis that there comes to them, because of their being engineers, the recognition that is due them, because of what the engineering profession has done for the service of mankind.

"I find it significant that when I talk to John Q. Public about the engineer and what he has done, that by and large the engineer is taken for granted . . . as a person who can do absolutely anything there is to be done—just give him time. . . . In this last war they saw the culmination of that thought in all its terror. So the engineers, in the mind of the public, are set apart. They are different. They, together with the scientists, go their respective ways. They have a knowledge of nature that takes them to the very ends of the universe. They can do anything. But, the engineer is not recognized as a force in civic affairs; he is just taken for granted.

"I believe," said Mr. Lee, "That the Institute of Tomorrow is going to have to give its thoughts, its ability, its understanding to bring recognition not only to the service rendered by electrical engineers, but also to add acknowledgment to all other engineers and to bring recognition from mankind to the services rendered by the engineer."

Section Management and Operation

To enhance the opportunity for direct and informal interchange of problems and experiences pertaining to the operation and management of local Sections, three separate conferences were held in parallel. as a supplement to the annual conference of officers, delegates, and members. One of these parallel conferences was devoted to the problems of the larger Sections, one to the problems of Sections of intermediate size, and one devoted to the problems of the smaller Sections. The following identical program was a guide for the discussion in all three meetings:

1. Safety activity.
2. Section finance.
3. Student activities.
4. Subsections.
   Five-minute intermission.
   Distribution of travel vouchers to delegates.
5. Educational courses and lectures.
6. Prize-paper competition.
7. Inspection trips and social activities.
8. Local councils of engineering and technical societies.
   Five-minute intermission.
   Collection of signed travel vouchers.
9. Section publicity.
10. Section programs.
11. Fellowship.
12. Other activities.

LARGER SECTIONS

The conference session concerning the larger Sections was presided over by R. M. Pfalzgraff, of the Philadelphia Section, with W. F. Henn (A '41) also of the Philadelphia Section acting as secretary. The highlights of this conference, as reported by Mr. Henn, were as follows:

Delegates from all 19 of the larger Sections were present. This group includes Boston, Chicago, Cleveland, Connecticut, East Tennessee, Los Angeles, Lynn, Maryland, Michigan, Milwaukee, New York, Philadelphia, Pittsburgh, St. Louis, San Francisco, Schenectady, Seattle, Toronto, and Washington.

Extended discussion emphasized the fact that there still is wide opportunity for the expansion of Section activities, especially in the direction of Student Branch activities and in the formation of Subsections for the benefit of groups in outlying communities. As a valuable agent to a seasonable program of technical meetings, one or two inspection trips per year designed to attract the general membership should be promoted.

Publicity was regarded by many as a very important item in the promotion of successful and well-attended meetings, and for many Sections the cost of such publicity appears to be a major item in the expense budget. Some suggestions were made that local Section finances could be helped considerably by supplemental sources of income such as local dues. To focus attention upon the important topic of industrial safety, and to facilitate the dissemination of practical and useful information on the topic, a suggestion was made that Sections occasionally should hold joint meetings with the American Society of Safety Engineers.

INTERMEDIATE SECTIONS

The conference of delegates representing the 29 Sections of intermediate size was presided over by G. W. Bower, of the Philadelphia Section, chairman of the AIEE Sections committee, with H. H. Sheppard (A '34) of the Philadelphia Section serving as secretary. The Sections in this group include: Akron, Central Indiana, Cincinnati, Dayton, Denver, Florida, Fort Wayne, Georgia, Houston, Kansas City, Lehigh Valley, Mexico, Minnesota, Montreal, New Orleans, Niagara Frontier, North Carolina, North Texas, Oklahoma City, Pittsfield, Portland, Providence, Rochester, San Diego, Sharon, Spokane, Syracuse, Vancouver, and Virginia.

The following notes summarizing the very lively informal discussion were furnished by Mr. Sheppard.

Safety activity in the Sections was discussed from the standpoint of the electrical engineer in relation to the design, construction, operation, and maintenance of electric equipment. The New Orleans and Denver delegates developed the idea that the safety angle could be brought effectively into the discussions of the technical meetings without the necessity of devoting the entire programs of meetings to the subject. In the discussion of Section finance, it was emphasized that Form 41, "Report of Meetings," should be sent promptly to headquarters covering all meetings conducted by each Section and each Subsection, including technical group meetings, inspection trips, and social functions, but not for meetings incidental to educational courses. Where joint meetings are held with other Sections, the host Section is responsible for submitting the report and both Sections are credited with the meeting. Clarifying questions raised by some delegates, discussion developed the fact that initial financial allotments to newly formed Sections or Subsections are based upon the quota of the appropriation year in which they officially are activated and cover the remainder of the appropriation year.

The plan for closer Section and Student Branch co-operation that was promulgated by joint action of the Sections committee and the Student Branch committee was discussed at length. Various specific methods of increasing student interest in Section activities were reported by the San Diego, Virginia, and Lehigh Valley delegates. The New Orleans delegate described the procedure of that Section in holding two joint meetings each year with the Branches at Louisiana State and Tulane Universities and reported that the Section each year presents a year's AIEE dues to the "outstanding student" based upon the students' own selection.

The Akron delegate reported that his Section holds one Section meeting each year, arranged by the students, and built around a program of about four student papers.

Subsections came in for extended discussion. In addition to the 31 Subsections listed in the 1947 AIEE Year Book, the following 5 newly formed Subsections were reported bringing the total of such units in active operation up to 33 (several former Subsections recently have attained the status of Sections):

South Texas Section; Subsection at Corpus Christi.
Ithaca Section; Subsection for Binghamton area.
New Orleans Section; Subsection at Baton Rouge.
Montreal Section; Subsection at Valley du St. Maurice.
Virginia Section; Subsection at Roanoke.

Enthusiastic reports covering the successful operation of their several Subsections were given by delegates from the Florida, New Orleans, Niagara Frontier, and North Texas Sections. The trend of the very active discussion on this subject indicated the great probability that many additional Subsections will be formed in the near future in the smaller communities. It was the consensus that such organization expansion could be possible wherever there is even a relatively small group of engineers that could be served effectively by such activity, and that such local groups might well include engineers other than electrical.

Educational courses as conducted by the New Orleans, Niagara Frontier, Pittsfield, Portland, and Spokane Sections were described. It was interesting to note that many of these courses were supplementary to courses given by near-by educational institutions. Several delegates reported their pleasant surprise at the large enrollment experienced by their Section for such highly specialized technical courses as studies of symmetrical components, servomechanisms, instrumentation, electronics, and for refresher courses designed to assist engineers in preparing for examinations incidental to state registration and licensing of professional engineers. Also, it was reported that educational courses for which a fee was charged showed a larger and better maintained attendance than free courses. Where fees are charged for educational courses, it seems to be fairly general practice to assess nonmembers a higher fee than members, with the difference being refunded subsequently to those who become AIEE members during the courses. In some instances, textbooks are presented at the termination of the courses in recognition of faithful attendance.

With reference to the subject of prize-paper competition, the chairman reported that a revision of the AIEE prize paper rule, drawn up by a special committee including members of the Sections committee and others for consideration by the board of directors at the current Montreal meeting, if adopted, would give AIEE national recognition to Section prize paper competitions and make available to each Section an annual prize of $25 together with suitable certificate. Several Section delegates expressed the opinion that this proposed national award for Sections use would be inadequate, some Sections reporting that they already provide more money for Section prizes than the Institute awards for its national prizes. The Mexico Section reported that a $200 first prize for paper competitions included a scroll carrying the "Code of Principles of Professional Conduct of the American Institute of Electrical Engineers" translated into Spanish. The general consensus, however, was that Section prize-paper competitions would be given effective stimulation by the proposed new rules.

With reference to the subject of social activities, the delegates from the Florida, Georgia, Kansas City, and Minnesota Sections emphatically recommended intermeetings. The Rochester delegate reported that his Section conducts occasional bowling parties and serves light refreshments. Interest in the activities of the Arizona Section was dramatized by the reported fact that the Sections program chairman lives some 250 miles from Phoenix where Sections meetings normally are held, but commutes regularly in his private airplane; many members are reported to drive regularly to the meeting from as far as 200 miles away. To afford maximum opportunity under these conditions for individual participation in both technical and social activities, the Arizona Section meetings were reported to be held usually on Saturdays and to include technical group discussions during the afternoon and a general dinner meeting in the evening.

More active Section participation in local engineering circles was recommended. Ways and means of expanding local Section publicity, including newsletters and directories were discussed at some length. Emphasis was placed on the desirability of Sections forwarding to headquarters for publication in *ELECTRICAL ENGINEERING* more items covering the nonroutine Section activities. Problems relating to the conduct of successful Section meetings, including the importance of better organized fellowship, were reviewed at some length, as also was the matter of expanding the number and size of Section operating committees to provide opportunity for individual participation and to improve the scope and quality of Section activities. The New Orleans Section reported that its history committee continues active and already has bound two copies of Section history complete with photographs of all class officers. The Mexico delegate reported that his Section has had an active history committee for several years, and that the Section planned a special publication in connection with its 25th anniversary (the Section was organized June 29, 1922).

The general consensus was that the mutual benefit derived from the exchange of ideas, the informal discussions, and the opportunities for closer inter-Section acquaintanceship, provided strong justification for the continuance of such informal conferences as an adjunct to the official annual conference of officers, delegates, and members, at the annual AIEE summer general meeting.

SMALLER SECTIONS

The conference of delegates representing the 30 smaller Sections, for the discussion of Section operation and management problems, was held under the chairmanship of A. C. Muir, of the Philadelphia Section, with John Gammell (M '45) of the Philadelphia Section acting as secretary. This group of Sections includes Alabama, Arizona, Arrowhead, Beaumont, Columbus, Erie, Illinois Valley, Iowa, Ithaca, Little Rock, Louisville, Madison, Mansfield, Memphis, Montana, Muscle Shoals, Nebraska, New Mexico–West Texas, Rock River Valley, South Bend, South Carolina, South Texas, Springfield, Toledo, Tulsa, Urbana, Utah, West Virginia, Wichita, and Worcester.

The smaller Sections delegates meeting was attended by 25 delegates out of a possible 31 and nine additional Institute members were present. No prepared discussions were planned, and remarks were from the floor as occasion offered. A brief period of comments was expected and encouraged on the following subjects: safety activity, Section finance, student activities, Subsections, educational courses and lectures, prize-paper competition, local councils of engineering and technical societies, Section publicity, fellowship Section meeting programs, and other activities.

Subsections and educational courses and lectures were the subjects which drew the greatest response from the delegates, and an accordingly liberal share of the time was devoted to them. Some Sections found that attendance was increased greatly for meetings to which members come from distant points by planning a general meeting on the scale of a minor convention. These general meetings were supplemented by Subsection meetings in local areas. Areas mentioned for Subsection organization were Binghampton, Elmira, Corpus Christi, Roanoke, Jackson, Nashville, and Tuscon. Interest in Subsections appeared to be unanimous.

While educational courses and lectures were not considered so widely and actively as Subsections, they were reported to be unexpectedly successful where tried. D. R. Hoopes (A '42) of Utah, mentioned very gratifying results with two courses: symmetrical components and vector studies of relaying and metering. Another on electronics is planned. E. W. Williams (M '45) of Montana, said his Section had put on a well-supported electronics course. T. A. Hopkins (A '44) of Illinois Valley, advised that his Section had worked out an educational series of lectures on illumination with a local utility. Others pointed out that utilities and manufacturers are apt to be pleased with the opportunity to help in the practical phases of these courses.

Prize-paper competition was encouraged. W. R. Abbott (A '40) of Iowa, and H. E. Ellithorn (A '40) of South Bend, both mentioned that they sponsored student paper activity with good results. R. R. Jenner (A '39) of Wichita, reported that his Section encouraged 10-minute speeches by members of the local Section on what they were doing. These speeches are given prior to the main talk of the evening. Members are interested and willing to participate in this kind of program and the results have been exceptionally fine.

Participation in the affairs of local engineering councils was urged, and a number of sections reported activity in this regard.

Fellowship matters were discussed, and the advantages of dinner meetings were pointed out. The expense of dinner has not been found to be a deterrent to attendance. A better job of greeting strangers was thought worthy of more consideration in most Sections.

Remarks by F. W. Norris (F '45) of Nebraska, concerning his 5- or 6-sheet mimeographed newsletters were intended particularly for outlying Districts with scattered membership. The newsletter was described as being personalized as much as possible.

T. A. Hopkins, of Illinois Valley, talked briefly on how large active groups at different geographical points in his territory had increased attendance astonishingly. He stated that two meetings a year were arranged for the general public.

In closing, the chairman suggested that Section work be spread among many operating committees. He also recommended that a history of various Sections should be prepared as soon as possible and kept up to date before data are forgotten or lost.

Technical Group Activities in the Sections

The extent and rapidity of growth of interest in technical group activities among the several Sections was evidenced at the summer general meeting in Montreal by the scheduling of a full afternoon's conference on the subject, and further by the lively exchange of ideas, problems, and questions which characterized the conference. Scheduled so that it would not conflict with any of the other administrative conferences of delegates and others, the conference was widely attended, delegates from coast to coast and from Canada to Mexico representing Sections of all sizes. This conference was held under the chairmanship of A. C. Muir, of the Philadelphia Section, with R. G. Porter, of the Boston Section, acting as secretary. The following notes summarizing the salient points discussed in the conference were provided by Professor Porter.

The opportunities available to Sections through the formation and operation of technical groups were described by Chairman G. W. Bower, of the Sections committee, in explaining the various methods of organization and procedure followed in the operation of such groups. The informality and flexibility of such activities were emphasized as lending themselves to local application in any pattern suggested by the peculiar needs or interest of any individual Section.

Technical group operation provides opportunity for active participation by many more individual members, expands the Section program in a way which provides effectively for the satisfaction of local technical needs and interests, and has attracted many new members from specialized fields.

Mr. Bower recommended closer co-operation between the various technical groups within the individual Sections and the appropriate national technical committees of the Institute, pointing out that such co-operation can be mutually beneficial in many ways. It is important to realize that the scope of this technical activity within the Institute covers the entire field of *ELECTRICAL ENGINEERING* subject matter. Mr. Bower pointed out that 40 different Sections currently are operating 123 technical groups, a record which he considers amply justifies the project of the Sections committee during recent years in encouraging technical group activities in the Sections. Mr. Bower urged other Sections to consider the advantages to be gained by the formation of such groups.

The plan followed by the Boston Section in technical group activity was described by Chairman T. S. Gray (F '45) of that Section. Starting with one technical group in March 1944, the Boston Section now has 9 technical groups, actively in operation; a tenth technical group, on the subject of basic sciences, currently is being formed to serve the interests of the more scientifically inclined members. Professor Gray also reported that the Boston Section is firmly convinced that technical group activities constitute one of the most stimulating and beneficial methods of serving the diversified interests of individual members that ever has been suggested.

Chairman-Elect W. A. Barden (M'46) of the Dayton Section, reported that his Section, established in June 1943, now has three active technical groups, each of which holds four meetings per year. The Section chairman appoints the group chairman who in turn selects a group secretary and proceeds with the group organization.

The Arizona Section, organized in March 1941, also has 3 active technical groups according to Chairman-Elect C. A. Poppino (A '42). Because Section members travel as many as 250 miles to a meeting of the Arizona Section, the periodic meetings of the 3 technical groups are held simultaneously, usually on a Saturday afternoon, followed by a dinner, a social hour, and the regular Section meeting in the evening. Mr. Poppino strongly emphasized the fact that the fields covered for each technical group must be "tailored to fit" the peculiar needs and interests of each Section. Kinard Pinder (F '45) past chairman of the Wilmington Subsection of the Philadelphia Section, described the operation and organization of the several technical groups which have been organized by the Subsection to cover several different technical phases of *ELECTRICAL ENGINEERING* subject matter.

CO-OPERATION BETWEEN SECTION GROUPS AND AIEE COMMITTEES

C. W. Lethert (M '44) of the Minnesota Section, and member of the AIEE Sections committee, opened an extended discussion of this subject in reporting that the AIEE committee on electronics had assisted electronic technical groups in various Sections by providing lists of available speakers, equipment demonstrations, motion picture films, and other such items. He recommended that the same procedure be followed by other Institute technical committees. Chairman J. D. Tebo (M '36) of the AIEE technical committee on basic sciences, discussed his method of reporting on the activities of his committee to his (New York) Section's basic sciences division. He urged that other Sections take advantage of the opportunity for similar close liaison through the various Section members who are members of AIEE technical committees. Doctor Tebo reported also that he had arranged the membership of the AIEE committee on basic sciences to include representatives of all Districts and as many individual Sections as possible.

Chairman W. R. Clark (M '45) of Philadelphia Section, reported that Section members who are active in AIEE technical committees have aided materially in the organization and operation of technical groups in the Section; also they attend these group meetings, participating in the discussion and aiding and securing qualified papers on special topics.

W. R. Hough (M '41) of the Cleveland Section, member of the AIEE Sections committee, discussed the methods of stimulating Section technical papers, suggesting the possibilities open to the technical groups for the stimulation of such papers; he also recommended that the Institute technical committees be furnished with a list of the various technical groups in operation in each Section.

A. H. Frampton (F '45) of the Toronto Section, member of the AIEE Sections committee, pointed out that the national structure of AIEE technical committees and subcommittees involves a membership of approximately 3,000 persons, thus affording opportunity for wide representation. He strongly urged that each Section study this national technical committee structure and keep Secretary H. H. Henline informed as to local members technically qualified and interested in serving on any of the national committees or subcommittees, especially urging that such recommendations from Sections be supplemented by a comprehensive outline of the qualifications of the committee candidate so suggested. Mr. Frampton recommended further that copies of all such letters and information should be sent also to the District vice-president.

T. M. Linville (M '34) of the Schenectady Section, member of the Sections committee, recommended greater and more effective 2-way co-operation between the various Section technical groups and the corresponding Institute technical committees, further suggesting that the Sections take action to bring the Student Branches in their territory appropriately into the program of technical group activities. Many other suggestions brought out in the lively discussion throughout the conference presumably will be carried back by the delegates to their local Sections for appropriate local use.

Facets of International Standardization Studied at All-Day Conference

An all-day conference on international standards was held June 10 during the Montreal meeting, with W. P. Dobson (F '43) chairman of the Standards committee, presiding. The purpose of the conference was to review existing American and European standards for switchgear, motors, and transformers and to generate ideas for their integration into a future plan of international standardization. This discussion was timely because of the plans of the International Organization for Standardization and the International Electrotechnical Commission for standards conferences in 1948, and the desirability of giving ample time for consideration of the data before such meetings are held.

After his introduction, Mr. Dobson introduced Donald Armstrong, now associated with Howard Coonley in the American Standards Association. Mr. Armstrong reviewed the history of the American Standards Association, originally developed to prepare engineering standards, and its recent expansion to cover standards for consumer goods. The ASA and similar strong national standards bodies form the essential foundation for the ISO that now is being formed. Before the recent expansion of the ASA much consideration was given to having the Government take over standards activities on a broad scale, but, after a thorough study, this plan was dropped in favor of the present democratic organization of the ASA.

In commenting on this, Mr. Armstrong referred to his Army experience years ago, when a single ordnance board decided on the specifications for Army weapons, and the Coast Artillery had to take what it was given. The soldiers disliked what they got, and the Ordnance Department came in for a great deal of caustic criticism. Consequently, the Army finally worked out a democratic organization for the control of specifications, in which the designers, the users, and the proving ground authorities all have a voice. This plan proved highly successful during the recent war. The new ASA organization is founded on this experience, as well as on the experience of industry in developing a very wide range of standards. Mr. Armstrong also mentioned the wise counsel and broad experience of Mr. Coonley, who is largely responsible for the present ASA and ISO organizational plans.*

To show the economic importance of sound standards, Mr. Armstrong cited an experience from the recent war, when a survey of the equipment needed for a single Army division showed requirements for 15,000 varieties of ball bearings, creating an almost hopeless problem of stocking and supply. Careful study, however, showed that only 1,700 of these ball bearings were really different, the remaining varieties being due to differences in the names and ordering numbers used. Similar conditions in other lines proved a tremendous handicap in war production; the lack of sound standards for screw threads alone probably led to an increased cost of approximately one half billion dollars for war production. Building up the industrial strength of the American continent should be a recognized object, as in no other way can we so greatly reduce the chances of war in Mr. Armstrong's opinion. Standardization, with all its benefits in the way of higher production and lower costs, is one of the greatest elements of strength in a peaceful America, as well as a most effective assurance against war.

Doctor Harold Osborne (F '21) vice-chairman of the United States National Committee of the International Electrotechnical Commission, then reviewed the formation of the IEC, originally suggested at the International Electrical Congress in St. Louis in 1904. The IEC adopted the basic electromagnetic units, including the gauss, oersted, and henry, and had under consideration before World War I new basic units in the meter-kilogram-second system, besides developing a number of standards for specific apparatus. In each country, there is a national committee of the IEC, with adequate representation of all technical interests. An international council representative of these national bodies meets periodically, and assigns responsibility for each technical subject to an advisory committee, with membership from all interested countries. There are 34 of these subjects now on the agenda of the IEC, as settled in Paris, July 1946. Among the most urgent are: standard voltages and currents, especially voltages above 220 kv; radio interference; lamp caps and holders; rotating machines; switchgear; insulation co-ordination; letter symbols; electroacoustics; and an electrical safety code. IEC meetings are held in two languages, French and English.

In conclusion, Mr. Osborne concurred with Mr. Armstrong's remarks on the fundamental importance of this international standards work, and its bearing on a peaceful world; remarking also that these things take a great deal of time, so that patience and perseverance are essential qualities in those who take part in IEC proceedings.

W. R. McCaffrey, director of the Canadian Standards Association, reviewed the work on Canadian standards, which has closely paralleled that of the ASA. He referred particularly to the Canadian Electrical Code, which has been developed over the past 15 to 20 years and now has been adopted by all the Canadian provinces as the basis for safety inspection. The CSA has arranged for the use of the laboratory of the Hydro-Electric Power Commission for product testing and is providing inspection service for manufacturers to determine if their products are being maintained at the level established by certification tests. This CSA certification service has been eminently satisfactory to all concerned. It is especially important in a country such as Canada, which imports so many types of equipment from abroad, where conditions are often very different from those prevailing in Canada. The codes have been helpful in enabling foreign suppliers to determine in advance the local requirements and so to avoid embarrassing rejections.

Doctor A. U. Lamm (A '35) of the Allmanna Svenska Elektriska Aktiebolaget, presented a paper on Swedish switchgear standards, written by Doctor Ivar Lindstrom. He stressed the detailed requirements for making and breaking duty set by these standards, as covered by five distinct tests under different conditions. A typical test is: 0–3 minutes—CO–3 minutes—CO; the 3-minute interval between circuit breaker operations being set by the test facilities rather than by the circuit breaker requirements. He pointed out that experience indicates this interval between operations in low oil capacity circuit breakers has no important effect on the circuit breaker's performance, and so need not be so short as required in some of the existing standards. The recovery voltage in each test is required to be 15 per cent above the rated value, minus 5 per cent tolerance; so that the circuit breaker is required to perform at 15 per cent above its rated capacity. For more than 70 kv, the recovery voltage may be considerably higher than this, so that a 50 per cent margin is desirable. However, the Swedish standards do not require this high value, but recommend that the purchaser tell the manufacturer what the conditions are and work out an agreement satisfactory to both parties in limiting cases. Work done in Sweden recently has enabled the natural frequencies of voltage oscillations in power systems to be calculated with satisfactory accuracy, from which the recovery voltages can be estimated.

In the absence of the author, Professor E. W. Boehne (F '43) of Massachusetts Institute of Technology, presented paper 47-161, "On Definitions of Magnitudes Characterizing the Behavior of Circuit Breakers Under Abnormal Conditions in American and Other Standards," by Professor S. Gerszonowicz (M '44) of the University of Montevideo, Uruguay. Some of the inconsistencies between the American and foreign switchgear standards brought out in the paper are: the American use of the rms value of the interrupted current, as against the symmetrical current in the German standards, and both these values in the IEC, British, and French standards; the omission of the tripping time in the American definition of the rated interrupting time; the lack of transient recovery voltage definitions in all standards except the American; and the failure of any standards except the American to distinguish between the making and the latching capacity. The author concludes that there is really a great need for action, national and international, to remedy the present confusion in switchgear standards. The rated interrupting capacity cannot be compared, because the standard duty cycles are different; nor can we compare the making capacity, because its measure has not been specified accurately; nor yet can we compare the short-time currents, because they are measured in different ways. However, these problems now are understood well enough to make the development of a sound international standard a hopeful, as well as a useful task.

One of the points deserving study, mentioned especially by Professor Boehne, is the effect on circuit breaker performance of the recovery voltage of the first pole to clear.

After Professor Boehne's presentation, the chairman opened the meeting to general discussion. Replying to a question, "What can the small Sections do about standards?" R. L. Jones (F '31) remarked that effective standardization depends on developing facts. The Sections can be of real help by holding meetings to discuss operating experience with all sorts of electric equipment, and writing H. E. Farrer (M '46) regarding any questions arising in the discussion that ought to be considered by the Standards committee. Section speakers also can be invited to explain provisions of various standards, and to show the economic benefits gained from them through the use of fewer varieties and preferred sizes of equipment.

Supplementing this, P. L. Alger (F '30) stressed the growing importance of thermal as well as insulation co-ordination of equipment for domestic, industrial, and power uses; and L. F. Hunt (F '38) observed that the needs for continually better circuit breakers have forced a steady improvement in switchgear standards.

Describing the organization and plans of the Standards committee, Mr. Dobson stated that the committee is anxious to get more young members interested. Service in the technical activities of the Sections, and on the technical committees, is an apprenticeship for later work on the Standards committee and the sectional committees of the ASA, where there are growing opportunities to render useful service to the electrical industry and the profession as a whole.

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* Making Democracy Work, Howard Coonley, *Electrical Engineering*, volume 60, July 1941, page 313.

At the afternoon session, C. A. Powel (F '41) presented a paper on AIEE Standards for preferred voltages, including a tabular comparison of the British and IEC power system voltages with those proposed for the United States. He emphasized that the vital problem is a definition of the favorable, tolerable, and extreme zones of voltage that are acceptable for a given nominal voltage. The standard United States utilization nominal voltage is 120 volts. The corresponding favorable zone is 110 to 125 volts, and the tolerable zone is 107 to 127 volts. It has been found expedient to use multiples of 120 for the nominal voltage value of all systems up to 14,400 volts, whereas multiples of 115 have been retained for nominal voltages of systems and circuits above 15,000 volts. A report on this whole subject, under preparation by the Edison Electric Institute—National Electrical Manufacturers Association joint committee, is expected to include apparatus design voltage tables, so that the document will form a rather complete report covering all phases of United States practice in regard to voltages above 100. It is hoped that the IEC may find this report useful in compiling a corresponding international voltage standard.

Mr. Powel also stressed the importance of agreeing on the higher voltage levels above 230 kv, before power developments requiring these voltages are undertaken. In view of the very steep cost curves of equipment for these higher voltages, it seems that the voltage steps of 300 and 400 kv listed by the IEC were chosen too far apart. It will be well for the IEC to consider carefully this point, and to adopt smaller voltage steps in the region above 230 kv.

W. R. Hough (M '41) presented a comparison of the American and foreign standards for induction motors. The American standards more completely define the service conditions than do any of the others, and the American standard is the only one that recognizes and defines a service factor. Temperature rise limits vary from 40 degrees by thermometer, or alternatively 50 degrees by resistance, in the American standards for general purpose motors; to 60 degrees by either thermometer or resistance in the Italian standards. Only the American standards define the torque limitations of induction motors; but the maximum torque is defined in effect by the British standards through the test requirements. All the standards except the American provide tolerances which apply to guaranteed performance values. The "AIEE Test Code for Polyphase Induction Machines" gives more complete information for testing than does any of the other standards. The author concluded that enough similarity exists between the standards to indicate that it would not be an exceedingly difficult task to obtain reasonable agreement in a new international standard for motors.

H. M. Jalonack (M '36) then presented a review of international transformer standards. He noted that the IEC, British, Australian, and French wartime standards specify from 5-to-15-degrees-centigrade higher temperature rises than the ASA value of 55-degrees-centigrade rise. It is understood, however, that the French practice now is going back to 60-degrees-centigrade rise, in place of the 70-degrees-centigrade value standard during the war. In order to adjust these differences, it appears reasonable for the ASA to consider increasing by 5 degrees centigrade the temperature rise for two classes of transformers: namely, the water-cooled and the forced-oil-cooled types. A conversion curve for comparing the kilovolt-amperes of oil-immersed transformers with various temperature rises is given in the paper, showing that a decrease from 70-degrees-centigrade to 55-degrees-centigrade rise is equivalent to an increase of 20 per cent in the kilovolt-amperes rating.

Differences also exist in the dielectric tests required by the various standards. It is particularly interesting to know that, with the neutral grounded, the ASA standards require a test of 2*E* (and there is a noticeable trend toward lower values where adequate lightning protection is provided at the transformer terminals), whereas the British Standard Specifications and IEC specify a test greater than 2*E* with graded insulation.

Perhaps the reason for these diametrically opposed practices is that the ASA tests are based on protection against lightning stresses, whereas the BSS and IEC tests are based on protection against expected operating frequency stresses. The reason for this difference in practice needs some clarification.

There are no impulse voltage test requirements in the British or IEC standards, but it appears desirable that impulse levels should be adopted internationally for the various voltage classes. The general use of tolerances in foreign standards makes it difficult to compare transformer performance with any accuracy. The author proposed that, in general, tolerances on losses, impedance, and other guaranteed performance values could be chosen to reflect normal design margins, so that the average test performance will be close to the warranty. In conclusion, the author recommended that the IEC give careful consideration to the following suggestions:

1. To reconcile the various national standards and practices to the maximum practical extent, with the final goal of having all national standards and practices eventually conform to IEC specifications.

2. To clarify any items of difference which still remain, and state the reasons for the divergence.

3. Where a universal standard is not adopted, to agree on conversion factors to convert one national standard to another by a definite numerical factor, so that intelligent comparison and evaluation of bids can be made when purchasing and selling in world markets.

Opening the discussion, P. L. Bellaschi (F '40) described his experiences abroad at IEC meetings and in South America; remarking that the wide differences in international standards are really due to fundamentals not having been brought to bear on the problems. It seems unnecessary, he said, to have such minor differences as both a $1^1/_2$–40-microsecond and a 1–50-microsecond wave for impulse tests, and to have reference values of about 20 and 25 degrees centigrade used in different standards. At the present moment, there is a real opportunity to do something useful by "getting off on the right foot" in the reopening of international standards meetings. Definitions should be the first concern, so that words will have the same meaning to all engineers, and then the fundamentals of each problem should be taken up.

He noted also that the authors of the transformer paper overlooked the Swiss and Swedish standards, which do include impulse levels. It is true that transformers of the same apparent rating may differ greatly, depending on the international standards with which they comply. A 70-degree rise transformer, for example, built to German standards with no impulse level may be one third smaller in effective output than a standard American transformer.

The authors explained that though they had endeavored to obtain copies of all foreign standards from ASA, that organization was unable to supply the Swiss and Swedish standards.

E. B. Paxton (M '25) noted that some of the differences in standards are due to differing points of view, but the better knowledge we now have should help us to reach agreement. It took two weeks in 1930 to reach agreement on the present values of temperature rise in the IEC motor standards. Since then, 10 degrees centigrade has been recognized, in place of 5 degrees centigrade, higher temperature rise by the resistance method than by the thermometer method in our own standards, and this will bring the standard more nearly in line with IEC thinking. Tolerances have been used abroad for a long time, but engineers in the United States generally have opposed them in favor of firm guarantees. There is a note in the IEC standards, requiring that tolerances be stated with any guarantees to which they apply; and the same thing could be done in the United States whenever tolerances are used in guarantees.

W. S. Peterson (F '46) agreed with Mr. Powel that voltage steps above 230 kv should be small. Tremendous investments are required for the power developments that need these high voltages, so that it is good sense to take only a moderate step at a time. The probable use of series capacitors and other means will permit the transmission of larger blocks of power than heretofore at existing voltage levels, giving the same result at lower cost as radically increasing the voltage. With regard to interconnections, most large systems need only an absolutely reliable power transfer in blocks equal to the largest single unit of the system. For short-time emergencies requiring still larger power transfers, the tie line may be operated at the steady-state limit of the system, accepting the risk of an outage, if a disturbance occurs that exceeds the transient stability limit.

R. T. Henry (F '33) pointed out that the growing use of grounded neutral systems with reduced insulation level is proving so satisfactory that it should be defined or recommended more clearly in the standards. Such a step will help to reduce the extra costs when system voltage is raised. He also remarked that the term "regulation" now is used to describe too many different things, so that its use should be defined more clearly and limited.

Returning to the motor standards, Mr. Alger asked if there are wide differences in the breakdown torques in the different standards. Mr. Hough replied that the British standards require 200 per cent for 40-degree motors, whereas the IEC require 165 per cent for 50-degree motors. The proposed NEMA standards now under consideration will require considerably higher breakdown torques for the smaller motors, up to 300 per cent for the 1-horsepower and fractional ratings. The starting currents, which are almost directly proportional to the breakdown torque, are not covered in the foreign standards.

W. A. Del Mar (F '20) suggested that the reason for the less specific requirements in foreign standards may be due to the general reliance on consulting engineers abroad to fill in these gaps, whereas in America the manufacturers are expected to do this. In this connection, F. J. Vogel (M '41) pointed out that the British standards do not specify the turn insulation level for transformers, but consulting engineers often do this. In the United States this is believed to be the designer's own responsibility.

Referring to Mr. Henry's comment, Mr. Powel stated that the different insulation levels for grounded and ungrounded systems are being included in the standards for lightning arresters. Each utility is free to adopt a preferred basic insulation level (BIL) for its system. It is just a question of what level can be protected. Mr. Henry suggested that different impulse tests on transformers should be called for, depending on whether or not it is grounded, so that the standards should go beyond the old BIL plan.

Mr. Del Mar also pointed out that the specifications for paper cables do not provide for ungrounded systems. Different insulation thicknesses are provided in low-voltage varnished-cambric cables, depending on whether they are grounded or not. Supplementary specifications for high voltage cables are desirable, with increased insulation, for ungrounded systems.

In concluding the discussion on motors, Mr. Hough said that experience in the United States shows it is necessary to define motor performance closely by both standards and test codes, to avoid wide differences between ostensibly similar motors from different sources. This more complete description is also necessary to enable users to apply motors properly. The foreign standards do not define motors as completely as American standards, nor as much as is thought necessary in the United States.

Mr. Svensson of ASEA, stated that the Swedish insulation standards to which Mr. Bellaschi referred came out in 1945. They are general standards for insulation, and give impulse levels for different types of apparatus. The values are fairly comparable with those of the ASA.

Referring to Henry and Powel's remarks, V. M. Montsinger (F '29) declared that when the BIL's were set up, they were not related to any specific system voltage, and so the user could select any one he wanted. He agreed with Mr. Henry that the ASA standards should be more specific. The 138-kv system is intended to have a 700-kv BIL as now given. Philip Sporn (F '30) uses one step lower than this, with a grounded system, and finds the performance very satisfactory. This should be included in future standards.

Student Prize Papers Presented at Summer Meeting

Late in 1944, the standing committee in charge of the administration of the member-for-life fund decided to utilize the fund to defray expenses of District Branch paper prize winners to the summer meeting where they would present their paper (*EE, Jan '45, p 31*). The member-for-life fund was set up at the January 1944 meeting of the AIEE board of directors by the approval and recommendations that the voluntary dues payments made by members-for-life be kept in a separate fund in the custody of the treasurer of the Institute. Originally, the awards were set up for a trial period applicable to the 1945 and 1946 summer meetings only. Last year a 4-year instead of a 2-year trial period was decided upon (*EE, July '46, p 351*).

Provisions of the annual award include payment of the expenses of five District Branch paper prize winners to present their papers on the regular technical program of the Institute summer meeting, awards to be available to even-numbered Districts for the summer technical meetings held in even-numbered years and to the odd-numbered Districts in the odd-numbered years, and expenses to be paid in the form of an allowance of 11 cents per mile one-way from the award winner's home town to the place of the summer technical meeting plus a reasonable allowance per day for the official duration of the meeting.

This year the summer meeting inaugurated the first award to prize winners of the odd-numbered Districts. Experience gained in the next four years will determine whether or not utilization of the members-for-life fund for this purpose will be continued permanently. J. F. Calvert (F '45) chairman of the electrical engineering department, Northwestern Technological Institute, Evanston, Ill., was assisted by Victor Siegfried (M '38) chief research engineer, electrical cable works, American Steel and Wire Company, Worcester, Mass., at the meeting where the prize papers were presented.

TORQUE SPEED TESTER

The prize winning paper from District 1 (North Eastern) was "A Torque Speed Tester for Electric Motors," as built by Professor George Pihl (A '45) Northeastern University, Boston, Mass., and presented by R. O. Williams (Student member).

The paper described a device which measures the torque and speed of small, fractional horsepower electric motors (less than 1/20 horsepower) under various load conditions. The tester comprises a mechanical and electronic unit. The mechanical part consists of the motor to be tested, a generator load, and two concentric shafts mounted on ball bearings and connected together with a helical spring which connects the motor with a generator. Mounted on the motor end of the shaft are two sets of contacts, one set to trigger the speed indicating circuit, and the other to trigger the torque circuit. The third set of contacts used to restore the torque circuit is mounted on the generator shaft.

As the motor turns the shaft, the grid resistors of a modified Eccles-Jordan trigger circuit of the torque unit, are short circuited to ground by the contacts for short periods of time. When there is no deflection of the spring, each resistor is shorted one-half revolution after the other and the circuit triggers alternately from one side to the other. As the spring deflects, the conduction on each side changes, one side getting longer and the other getting shorter. As the load increases, the spring deflection increases and the average current through the meter increases in proportion to the torque.

The speed circuit is somewhat more complex in number of elements, with the output of a modified Eccles-Jordan circuit fed into vacuum tube voltmeter. The rotating contact is arranged so that one half of the Eccles-Jordan circuit tube conducts for each half revolution of the shaft. Two capacitors in the circuit are proportioned to divide the speed range in equal halves of from 0 to 5,000 rpm and from 0 to 10,000 rpm. Provision is made for calibration of both torque and speed as measured by the instrument and close agreement with manufacturers' curves shows that the calibration of the instrument is satisfactory.

M. F. Pravda (Student member) Newark (N. J.) College of Engineering, presented his paper "Graphical Method of Determining the A-C Resistance in Single Layer Coils," which was the prize winning paper for District 1 (New York). The problems encountered in coil design and construction, both mathematical and physical, many times had suggested the need for some simplification. Whether such simplifications are justified from a designer's point of view is doubtful, but that they have proved useful for quick comparisons of coils without undue effort and with a fair accuracy may suggest their usefulness. A simplified discussion of the derivation of the method of computing resistance was included.

PROGRESSIONS

"Progressions Applied to Engineering Problems," the prize winning paper from District 5 (Great Lakes) was presented by H. M. McConnell (Student member) Marquette University, Milwaukee, Wis. Some problems in engineering practice involve the use of geometrical progression. In some cases the graphical solution is inadequate and, in order to eliminate the errors of a graphical solution, a direct mathematical approach is desirable. Formulas are given for applications involving resistance taper in motor control design, and for louver spacing.

The last paper to be presented was "The Phantastron Control Circuit," by J. R. McDade (Student member) Southern Methodist University, Dallas, Tex., which was the prize winning paper from District 7 (Southwest). Rapid development of electronics during the war has led to and been supported by continuously improved and increasingly complicated control circuits. One of the newer types of control circuits, the phantastron, is an improvement over the conventional type of delay multivibrator circuit and perhaps may find extensive application in television.

Five-Year Curriculum Engrosses Education Session

At a conference on education held in Montreal June 9 under the chairmanship of J. G. Tarboux (F '43) of the Ithaca Section, chairman of the AIEE committee on education, four informal conference papers were presented and discussed extensively. The main theme of this important conference was the question of the adequacy of present-day engineering education, which subject was complemented by discussions of the new 5-year engineering curriculums as interpreted by various United States colleges.

In discussing "Graduate Work in Electrical Engineering," Past President R. W. Sorensen (F '19), professor and head of department of electrical engineering, California Institute of Technology, Pasadena, outlined the graduate program at that school. He particularly stressed the fact that all graduate work, to merit classification as such, should be not merely a continuation of the same type of work provided for in the undergraduate curriculum, but should be of a distinctly higher caliber designed to challenge the development of individual talent. The graduate program at California Institute of Technology offers a professional degree at the end of two years of graduate residence work and a doctorate after three years.

The "Five-Year Engineering Curriculum" recently introduced at Ohio State University, Columbus, was described by E. E. Dreese (M '25) chairman and professor of electrical engineering at that institution. Professor Dreese called this 5-year curriculum "An experiment in engineering education," and pointed out that one interesting feature of the program is provision 4, a master's degree at the end of five years to be available to the "superior" student by modification of the last two years of his work. A comparison of the Ohio State 5-year program with the new 5-year program at Cornell University is given in the two accompanying tabulations, furnished by W. E. Maserve (M '33) associate professor of electrical engineering, Cornell University. Cornell does not provide for the masters degree at the end of five years.

The present and the future needs of industry with reference to engineering education were portrayed most interestingly by H. N. Muller (M '43) manager of graduate student training for Westinghouse Electric Corporation, East Pittsburgh, Pa., under the title "Young Engineers in Industry." Mr. Muller outlined the training program of the Westinghouse Corporation, and stressed the need for broad basic training in the engineering schools, with proper attention to the so-called "humanistic" social courses as well as to technical subject matter.

Swinging from educational philosophy to

Table I. Five-Year Engineering Curriculum

Comparison Between Ohio State and Cornell Requirements for Bachelor of Electrical Engineering Degree

Ohio State	Quarter Hours	Semester Hours	Cornell		Semester Hours
Mathematics—3 yrs.	39	26	Mathematics		15
3-yr mathematics (9 hrs) in advanced engineering mathematics			3 hrs engineering mathematics, 3 hrs differential equations		
Chemistry—freshman	12	8	Chemistry—freshman		6
Engineering drawing—freshman	12	8	Engineering drawing—freshman		6
Survey of engineering	2	$1^{1}/_{2}$			
English—freshman	9	6	English—freshman		6
Survey of English—senior	1	$^{2}/_{3}$			
Military science and physical education	16	$10^{2}/_{3}$	Military science and physical education, not credited toward degree		0
Physics, mechanics of sound, heat, and light	10		Physics, mechanics of heat, sound	6	
Electricity and magnetism	13.... 23	$15^{1}/_{3}$	Electricity and magnetism, light	6	
			(Modern atomic, etc.)	3	15
Engineering Mechanics			Engineering mechanics		
Statics, structural materials, dynamics	13	$8^{2}/_{3}$	Statics, structural materials, dynamics	9	
			Kinematics	2	
			Fluid mechanics	3	
			Structures	2	16
Elementary machine shop	3	2	Elementary machine shop		4
			Surveying		1
			Engineering chemistry		
			Organic		2
			Physical		2
			Engineering materials		3
Mechanical engineering, thermodynamics, heat transfer, machine design	14	$9^{1}/_{3}$	Mechanical engineering, thermodynamics, heat power	6	6
Electrical engineering	55	$36^{2}/_{3}$	Electrical engineering		
			Common to all options		40
Technical electives and options	31	$20^{2}/_{3}$	Option courses		18
			Electives		6
Speech	5	$3^{1}/_{3}$	Speech		3
Economics	6	4	Economics		3
			Accounting		3
Sociology	6	4			
			Psychology		3
History, United States or European	6	4	Modern economic history		6
Broadening elective	21	14	Broadening elective		9
			Project		6
	274		Total		179
Off-campus summer experience	5				
	279	186 Semester Hours			

Table II. Comparison of Distribution of Hours Required by Ohio State and Cornell for Bachelor of Electrical Engineering Degree

Ohio State 274 Quarter Hours (182 Semester Hours)	Quarter Hours	Semester Hours	Cornell 180 Semester Hours	Semester Hours
1. Fundamentals:			1. Fundamentals:	
Mathematics	39	26	Mathematics	15 hrs
Physics	23	$14\frac{1}{3}$	Physics	15
Chemistry	12	8	Chemistry, materials	13
Drawing	12	8	Drawing	6
Mechanics	13	$8\frac{2}{3}$	Mechanics	16
	99 or 36.1%			65 or 36.1%
2. Broadening:			2. Broadening:	
English	9	6	English	6
Speech	5	$3\frac{1}{3}$	Speech	3
Economics	6	4	Economics and accounting	6
Sociology	6	4		
	0	0	Psychology	3
History	6	4	History	6
Broadening electives	21		Broadening electives	9
	53 or 19.3%			33 or 18.3%
			Possibility of 6 hrs additional	6
			increasing total to	21.1%
3. General requirements:			3. General requirements:	
Physical education and hygiene	4	$2\frac{1}{3}$	Credit for physical education and military science not included in the 180 hours toward degree.	
Military science	12	8		
Freshman survey	2	$1\frac{1}{3}$		
Senior survey	1	$\frac{2}{3}$		
	19 or 6.9%			0%
4. Departmental:			4. Departmental:	
Shop	3	2	Shop surveying	5
Mechanical engineering	14	$9\frac{1}{3}$	Mechanical engineering	6
Electrical engineering			Electrical engineering	
Circuits	15	10	Circuits	8
Circuits laboratory	8	$5\frac{1}{3}$	Circuits laboratory	3
Electives	6	4	Electives	6
Electronics laboratory	4	$2\frac{2}{3}$	Electronics laboratory	4
			Electronics theory (communications systems)	8
Field theory	3	2		
Electric machine theory	4	$2\frac{2}{3}$	Electric machine theory	6
Electrical engineering economy	3	2		
			Nonresident lectures	1
Electrical analogs	3	2		
Technical electives and options	31	$20\frac{2}{3}$	Technical electives and options	18
			Writing and technical reports	3
			Project	6
	103 or 37.6%			82 or 45.5%

specific teaching methods, E. E. Moyer (M '44) of the electronics section, industrial control engineering division, General Electric Company, Schenectady, N. Y., described "A Means for Demonstrating the Behavior of Conventional Types of Instruments in Circuits Having Potentials and Currents of Irregular Wave Form." Mr. Moyer brought out the fact that conventional instruments, once subjected to complex wave forms, often will give misleading information even though they actually are doing the job for which they originally were designed. He exhibited a demonstration board designed to show these effects. This demonstration was of importance in showing how simple it actually is to teach difficult and complicated engineering concepts by means of well planned "props" of apparatus which provides animation, something physical to look at. The demonstration of instrument behavior under conditions of irregular wave forms was much more convincing, and much more interesting, than mere lecture and textbook material.

DISCUSSION INDICATES WIDE INTEREST

The subject of the 5-year engineering curriculum elicited an extensive discussion, indicating a very broad interest current in the electrical profession pertaining to the present emphasis on graduate work and the results of the present experimental trends toward 5-year programs for engineering undergraduates.

To a question as to why the undergraduate thesis is not required at California Institute of Technology as it is in other schools, Doctor Sorensen replied that for the new 5-year curriculum the thesis deliberately is omitted, although it is required as usual in the master of science and doctorate degrees. He stated that the 5-year curriculum provides many more of the so-called "humanistic" or social studies for broadening purposes, therefore the thesis does not find the same use as it does in the other curriculums. Admitting that the thesis provides a means of interpreting the students' aptitude in original thinking, Doctor Sorensen expressed the view that it is of perhaps more value in courses of study leading to research degrees than it is for the engineering graduate contemplated in the 5-year courses. Doctor Sorensen reported further that students pursuing studies for doctorate degrees are permitted to take part-time teaching employment up to 60 hours per week.

Professor Ernst Weber (F '34) head of the graduate electrical engineering department, Polytechnic Institute of Brooklyn, N. Y., stated that in his opinion the master's thesis is the one which provides information about the student, and that it cannot be combined with the 5-year plan. Professor F. O. McMillan (F '32) head of the electrical engineering department, Oregon State College, Corvallis, expressed the belief that there is need for a uniform basis of masters' and professional degrees; otherwise, with the 5-year program the master's degree will lose its significance. He stated that he considered the master's degree to be most important in discovering the resourcefulness of the individual student as a candidate for the doctorate degree. Professor Dreese expressed the belief that the master's degree should be, in effect, a "little doctorate" and not simply an extension of undergraduate work. He advanced the further opinion that, in general, the professional educational requirements need raising, stating that an engineering degree is not comparable to a commercial degree. He further stated that at Ohio State University social studies are oriented toward engineering but are available to nonengineering students.

Professor M. G. Malti (M '45) professor of electrical engineering, Cornell University, Ithaca, N. Y., expressed the belief that "A return to fundamentals of education is necessary, to prevent losing the objectives." In engineering education, he stated, the objective should be (1) to train the mind and (2) to instill social consciousness. "The particular courses do not matter so long as they serve effectively as vehicles to train the mind. . . . . Design is not fundamental but provides a balance between economics and usefulness. . . . . Social consciousness as provided by extra courses such as history, are not enough." Professor Malti stated further that "Today the social sciences are definitely behind engineering science, and hence a much higher degree of social consciousness is needed in our engineering curriculums. . . . . One way of accomplishing this would be to make the bachelor of arts degree a prerequisite to the engineering degree."

Doctor C. L. Dawes (F '35) associate professor of electrical engineering at Harvard University, Cambridge, Mass., reported that the Harvard University 5-year course in engineering was started as an experiment because "Industry was demanding more of the broadening courses . . . . and because we realized that a law degree takes seven years and a business degree six years; . . . . After 1936 an engineering degree was not granted for less than five years of work." Doctor Dawes reported that the same humanistic studies are demanded of the engineering students as are demanded of others. At the end of the fourth year, only a bachelor of arts degree is granted.

At this point, many students, although not having attained an engineering degree, are attracted into industry. Doctor Dawes reported that "the number of engineering students increased during the war, and now everyone wants the doctor of science degree. . . . . however, it does not have a frozen curriculum . . . . the Engineers' Council for Professional Development set standards for fundamentals, but it is the custom at Harvard to use specific engineering courses as vehicles for fundamentals—for instance, a course in electric power transmission may be used more as a vehicle to teach differential equations than to teach the details of transmission."

As indicated by Doctor Dawes' comments, one of the problems involved in the 5-year engineering curriculum is that of student finances. Industrial opportunities give the student a tremendous urge to begin to earn, by the fifth year, instead of continuing his academic work. It was the consensus that substantial aid will be necessary to offset such industrial demand and encourage qualified students to continue their academic work to higher levels.

Notes for the foregoing report were provided through the co-operation of J. A. Northcott Jr. (M '40) head of the department of electrical engineering, University of Notre Dame, South Bend, Ind., and secretary of AIEE committee on education; and C. C. Wilson (M '43) of the AIEE headquarters staff.

Two Lively Sessions Devoted to Paper Mill Processes

Power supply and equipment were the subjects of two technical sessions devoted to paper mills on June 10. The morning session, to which a discussion of power supply in paper mills attracted more than 200 representatives of manufacturers, paper mills, and utilities from the United States and Canada, was the third in a series of industrial conferences sponsored by the committee on industrial power application at national AIEE meeting. It was presided over by L. A. Umansky (F '45) assistant manager, industrial engineering divisions, General Electric Company, Schenectady, N. Y.

The conference papers were arranged in logical order from the utility power tie through distribution and included the electric production of steam by electric boilers, electric motors, drives and control for paper mills, and two papers on maintenance. The papers inspired a healthy and spirited discussion on the advantages of grounding practice, mechanical versus the electronic speed controls, and maintenance practices.

POWER TIE WITH UTILITIES

"Power Tie with Utility," a conference paper by A. P. Schnyder (M '32) electrical engineer, George F. Hardy and Son, Consulting Engineer, New York, N. Y., represented the operating man's viewpoint. According to Mr. Schnyder, the primary economic function of a power tie with utility where the mill generates steam and power is to have the utility act as the condenser with power flow in both directions. The utility plant, on the other hand, can be expected to generate condensing steam power more efficiently, competently, and reliably from operating standpoint. In a paper mill, power generation is incidental whereas for the utility it is the end product when delivered to the consumer's premises. The great majority of pulp and integrated mills limit the power tie, when used, to the convenience and safety of having a standby source in case of accidental failure of the mill's power plant and to supply the mill essential services during protracted mill shutdown.

The most serious objection to the power tie for supplying process power is the result of possible line outages. The longer a transmission line, the more likely a power interruption caused by nature, and power failures are costly for mills in loss of production and spoilage. Mr. Schnyder's conclusions were that the power tie to paper mills is essential in regions of hydroelectric power, owned exclusively by power companies or the public, and where the cost of fuel is high enough to render steam power generation comparatively profitable. However, where the fuel cost is moderate, and the mill has an up-to-date power plant, the usefulness of the power tie is limited to carrying the marginal amount not available as by-products from process steam passing through turbines. In most instances the power tie is a source of standby power.

AUTOMATIC OPERATION

In his paper, "Automatic Operation of Electric Boilers", M. Eaton (A '44) electrical engineer, Shawinigan Chemicals Limited, Shawinigan Falls, Quebec, Canada, discussed the principles of automatic control with reference to air-operated controllers, reviewed early methods of regulating electric boilers automatically, and described later improvements based on fundamental principles. In the choice of a control, the capacity lag is usually the determining factor. When the capacity lag is large, compared with the controller and transition lag, a simple 2-position controller may be adequate. Proportional control is satisfactory with moderate lag. If the capacity lag is small compared with the other lags, and large changes in demand for control agents occur, proportional-speed-floating plus reset controller action is required. Electric boilers usually are regulated by maintaining the salt content within limits by bleeding and by varying the water level on the electrode in accordance with the demand for steam. Power input is matched with steam demand to maintain constant pressure. The power input is the control agent supplying the heat energy required to generate steam, and the electrode immersion is the final control element. As steps in the history of automatic boiler control, Mr. Eaton described the Cascade Inn boiler control, the conductivity control, the water level control of the step type, the surge tank-control of the Dominion Engineering Company, the automatic control of the Canadian General Electric Company, and the automatic control of the water level type.

UTILITY VIEWPOINT

"Electric Boilers From the Utility Point of View," by L. B. Stirling (A '25) superintendent, generating division, Shawinigan Water and Power Company, Shawinigan Falls, Quebec, Canada, was a most interesting conference paper portraying the reversal of the usual order of things; that is, the production of steam by electricity. Electric boilers often are used to take up excess from hydroelectric stations at a very nominal cost. Compact and clean installation subject to exacting control (the importance of exacting control on electric boilers can be realized when it is known that the present installation exceeds 2,000,000 kw) makes this an attractive source of process steam where hydroelectric power is reasonable. The cost of coal-fired steam power in Canada is about 1.5 mils per kilowatt-hour. In 1946 alone, some 1,000,000 tons of coal were saved by the use of electric boilers.

LOW VOLTAGE DISTRIBUTION

"Low Voltage Distribution In Paper Mills", A. C. Bird (A '20) project engineer, H. S. Ferguson and Company, New York, N. Y.; W. C. Bloomquist (M '45), industrial engineering divisions, General Electric Company, Schenectady, N. Y. Commenting that he saw no necessity for repeating the material contained in the copies of the Bird and Bloomquist conference paper which he passed out to those present, Mr. Bloomquist instead extended his discussion of grounding as contained in the paper. He pointed out the extreme inconsistency prevalent in grounding practices for various voltages from 115 to 2,400. He definitely recommended the grounding system, pointing out that the cost of locating ground faults is high. In general, the steel mills use a grounded system, having recently changed over.

One of the advantages of a grounded system is that the operation of the system relays is far more consistent. Also, only 2-element circuit breaker protection in motor circuits is required. The "down time" averaged over a period of time will be found to be less if the system is grounded. However, there is great need for actual operating data for grounded systems versus ungrounded. Mr. Bloomquist recommended that transformers be ordered with the neutral brought out. In this way, the grounded system can be tried and the neutral unused if it is found unsatisfactory. A Mr. Sheehan from Niagara Falls pointed out that grounding is undesirable on a Y-Y transformer installation as the triple harmonics produced affect signal systems, and so forth, and tertiary windings are expensive. Mr. Bloomquist explained that a delta-Y stepdown (delta on the primary winging) is the usual practice, eliminating the third harmonic. Grounding sources should be kept to a minimum to avoid complications. When several distribution voltages are required, series stepdown can be used but always delta-Y.

A conference paper "High Voltage Distribution in Paper Mills," by G. H. McHenry and J. L. McKeever (A '32) of the Canadian General Electric Company, Limited, Peterboro, Ontario, Canada, also was presented. The authors classed North America's pulp and paper industry as one of the continent's major power consumers. This industry is especially important in Canadian economy because newsprint from ground wood mills is one of Canada's main products. Pulp and paper mills range in size from the very small specialty paper mill with a total power requirement of 2,000 kva or less, up to the very large ground wood pulp and paper mill having power requirements of the order of 750,000 kva or more. Because of the great variety in the industry, the ideal distribution system for any given plant should be developed from fundamental considerations rather than by adaptation from other installations.

Discussers of papers at this session included E. W. Knapp and R. B. Reed, both of the Shawinigan Water and Power Company, and F. L. Lawton of the Aluminum Company of Canada.

EQUIPMENT IN PAPER MILLS

A June 10 afternoon technical session, on equipment in paper mills, also was under the chairmanship of L. A. Umansky. At this session considerable discussion took place among representatives of different paper mills with regard to their respective practices and equipment.

SYNCHRONOUS MOTORS FOR CHIPPERS

"The Application of Synchronous and Induction Motors to Chippers", R. R. Baker, M. R. Lory (A '40) both of the Westinghouse Electric Corporation, East Pittsburgh, Pa., pointed out that large chippers for reducing large logs to chips suitable for digesting into paper pulp used direct-connected low-speed synchronous motors.

These large chippers are common on the West Coast and are of the 110-inch diameter and larger size.

Occasionally a belted drive with a synchronous motor is used, but usually it is worth while to direct connect the motor to avoid belt maintenance. Direct drive, of course, involved vibration of motor shaft, and the load impulse must be kept away from the natural torsional oscillation of the chipper. Smaller shafting will help.

PAPER MACHINE DRIVES

In a conference paper "Paper-Machine Drives", H. W. Rogers (A '12) engineer, paper and textile division, industrial engineering divisions, General Electric Company, Schenectady, N. Y., pointed out that while the industry as a whole presents many interesting problems, the most important machine in the paper mills is still the paper machine, the continuous, uninterrupted operation of which is paramount. There are two distinct types of paper machine to be found in the industry; the Fourdrinier machine, named after its sponsor, and the cylinder machine. These two machines, with some modification, are used in the manufacture of all grades of paper and board.

Mr. Rogers also discussed the two types of drive in general use on paper machines. These are the mechanical or line shaft drive, which is in reality a group drive, and the sectional electric drive. As an example of the progressive attitude of the paper industry, he contrasted one of the more recent sectional electric drives which was equipped with almost 70 main and auxiliary motors, with the first modern sectional drive which had only eight motors.

MAINTENANCE

W. L. Eliason (M '44), electrical engineer, Ontario Paper Company, Limited, Thorald, Ontario, Canada, in his conference paper, "Electrical Equipment Maintenance", stated that one principle of circuit breaker and contactor maintenance was that of inspection of contact. Often the contacts are inspected, many times filed and cleaned, but rarely are the contact pressures checked and corrected. It was agreed that a good general principle to follow is never to touch a contact surface except in extreme instances, and to make the checking of contact pressures an item of regular maintenance. Insulation resistance of equipment, it was pointed out, should be taken under hot and full load conditions.

FINISHING ROOM EQUIPMENT

"Electric Equipment in the Finishing Room", M. Winterburn, Howard Smith Paper Mills, Limited, Cornwall, Ontario, Canada. The diversity of equipment used in any finishing room depends upon the type of paper being produced in the mill and also on the amount of fancy finishing desired. Some mills, such as those producing newsprint, normally confine their finishing operation to rewinding and splitting defective rolls; others, such as those in the fine paper field, go in for a multitude of finishing or secondary processing which changes the visual or physical characteristics of the original paper. The equipment to be found in the finishing room of fine paper mills depends upon the grades of paper produced, but most of these departments will have such machinery as supercalenders, cutters, trimmers, embossers, platers, and some will have, in addition, coaters, conditioners, and other special apparatus for some particular purpose. As each machine is required for a different purpose, its drives must be designed to conform to the conditions of its operation. Lighting is also important and the modern trend has been toward the fluorescent unit which has proved so popular and economical, particularly when power cost is high.

Mr. Winterburn reminded his audience that most of the fine paper mills are old established concerns and much of the equipment, although adequate, is far from modern. Thus, he believes, there is a definite field for development in finishing room electric equipment and there electronics will find many applications.

NEWS PRINT MILL

"Planning a Newsprint Mill for Minimum Electrical Maintenance", John Eyton (M '45) engineering department, Abitibi Power and Paper Company,. Limited, Canada. Electrical maintenance, stated Mr. Eyton, depends, in a newsprint mill, on the type of apparatus installed, the systems of distribution used; the facilities provided for their upkeep and their proper use. By the proper selection and use of these, electrical maintenance should be highly efficient and profitable. The requisites for maintenance are spares, standardization of equipment, shop and office space, tools and instruments, and a competent staff. Provided the proper methods are followed, records of equipment kept, and performances of apparatus checked, results should include fewer work stoppages, fewer replacements, longer useful life of equipment, as well as reduced time on repairs and overhaul.

In a general discussion of the subject, equipment of paper mills, J. L. Fuller, Reliance Electric and Engineering Company, pointed out the advantage in the single main generator systems using a booster for each motor for speed control. The small boosters have rapid response and motors can be cut out individually. H. W. Rogers replied that booster generators are not used, having been used 25 years ago to avoid loss of torque of motors at low speed. Any differential device, he said, is inherently slow, and an electronic device can be made to operate to correct speed more immediately.

Frank Cramer, Carnegie Illinois Steel Company, asked what device is used in paper mills which corresponds to the tensiometer in steel mills. (Any such device mechanically sensing the tension of the papers presumably would break the paper.) The answer was that the speed of paper mill motors is governed very closely. For instance the motor current is held by a device in the dry end of the paper machine only. Hunting and overshooting of servo devices has been eliminated.

It also was pointed out that electronic detection of defects in paper is being investigated but that automatic sorting is not so far along. Electronic detection of moisture in cigarette paper also is being developed. It was said that there is a great deal of room for improvement in supercalenders and finishing room equipment. The electrical engineer should lead the way toward this improvement.

Improved City Transit Systems; Rail Equipment Described

Five technical program papers made up the program of the technical session on land transportation, under the chairmanship of W. A. Brecht (M '39) of the Pittsburgh Section, manager of transportation engineering, Westinghouse Electric Corporation, East Pittsburgh, Pa.

Three of the papers had to do with system plans and equipment development for rapid-transit subways, while two of the papers described modern railway passenger car auxiliary equipment required for the expanding use of electric power on main line railway cars for such purposes as air conditioning, fluorescent lighting, air cleaning, and water cooling.

W. E. P. Duncan described the "Proposed Rapid Transit System for Toronto," discussing the plans of that city to expend the sum of $55,000,000 on two subway rapid-transit lines to relieve surplus traffic congestion. The plan calls for subways of the latest design and construction, with stations arranged wherever possible for a mezzanine floor between the track level and the street level for fare collection and passenger control facilities. For rolling stock, the plan is to utilize an adaptation of modern lightweight Presidents' Conference Committee streetcar equipment, arranged for train operation. Power for supply for trains will be at 600 volts direct current supplied by 1,250-kw mercury-arc rectifiers set from 13.2-kv 3-phase 25-cycle supply circuits. The use of PCC cars for the subway system will fit in with the same transit car as used for surface lines in Toronto.

The motors and control equipment designed for the latest model cars now under construction for the New York subway system, were described in two papers: "The Design of New York Subway Motors for Dynamic Braking," by B. A. Widell (M '26) transportation motor engineering department, General Electric Company, Erie, Pa.; and "Motor Control for New York City Transit System Subway Cars," by L. G. Riley (M '45) transportation engineering, Westinghouse Electric Corporation, East Pittsburgh, Pa. This equipment is radically different from subway equipment currently in use. The traction motors are entirely spring borne and, in spite of being very much lighter in weight, will provide for more rapid acceleration and quieter operation. The control for these motors has been designed especially to give fluid acceleration and retardation; the braking is chiefly electrical, the motors being utilized as generators.

The latest developments in PCC street cars and trolley coaches were discussed by W. J. Clardy (M '39) transportation application engineer, industry engineering department, Westinghouse Electric Corporation, East Pittsburgh, Pa. Mr. Clardy extolled the superior operating characteristics of these vehicles, and emphasized their value as man-transportation vehicles which "make much more efficient use of crowded street space in our busy cities than does any other type of public or private vehicle." Wartime experience was cited as demonstrating these vehicles to be easier and less costly to maintain than other types of passenger vehicles.

"Modern Railway Passenger Car Auxiliary Power Equipment" was described by D. R. MacLeod (M '41) and Jack Hause (A '35) both of the transportation division, General Electric Company, Erie, Pa. With at least two railroads experimenting with full-scale electric cooking equipment, with the demands of air conditioning and refrigeration, with consideration being given to electric blankets for sleeping cars and coaches, and other such devices as individual roomette refrigerators and electric warmers for babies' milk, electric supply equipment for railway cars is becoming a major problem. Conventional dining cars now are being equipped with generators of up to 50-kw output; coaches and sleeping cars with generators up to 35-kw output. A 20-car train may require as much as 800 horsepower from the locomotive for train electric power supply. Electric loads of such proportions are causing serious consideration to be given to the replacement of the traditional axle-driven generator by individual engine-driven generators on each car, or the development of a standardized system for supplying train loads from generators carried on the locomotives.

Heating Problems, Furnaces, and Industrial Voltages Discussed

The Montreal technical session on industrial voltage requirements was under the chairmanship of C. C. Whipple (M '26) professor and acting head of electrical engineering, Polytechnic Institute of Brooklyn, N. Y. This was, in effect, a miscellaneous section, accommodating the presentation of 5 technical program papers, 4 concerned with some phase of electric heating, the fifth constituting the session-title paper "Report on Industrial Voltage Requirements," prepared by the subcommittee on industrial voltage requirements of the AIEE committee on industrial power applications.

The work of the subcommittee is a sequel to the work done by the industrial power application committee in the preparation and issuance in 1944 of the bulletin on "Electric Power Distribution for Industrial Plants." The information and opinions accumulated in the preparation of this earlier work and in a review of the work of the Edison Electric Institute–National Electrical Manufacturers Association joint committees on standards for distribution transformers, and on preferred voltage ratings for a-c systems and equipment, indicated the desirability of more study being given to the subject of industrial voltage requirements from the standpoint of the equipment users. The AIEE subcommittee, during the past two years, has developed a report and recommendation which is now in tentative, final form as AIEE paper 47-157 under the afore-mentioned title. The report is divided into six parts:

1. Introduction, which covers the objectives and scope of the work.

2. Work of the committee, which covers the various surveys and progress reports.

3. Basic principles of industrial voltage distribution, which covers explanation of terms, effect of voltage drop and effects of equipment that result from voltage spread.

4. Recommended voltage spread for industrial power applications, which covers results of surveys and makes recommendation of voltage spread at utilization equipment.

5. Voltage readings and taps for industrial power transformers, which covers the problem-factor influencing the application of transformers, recommended voltage ratings and taps for industrial power transformers, and agreements with and recommendations to EEI–NEMA.

6. In conclusion the basic objectives of this subcommittee's work are (*a*) To show the importance of proper utilization voltage to the satisfactory operation of industrial electric apparatus; (*b*) To recommend voltage spreads at the terminals of utilization devices under normal operating conditions; and, (*c*) To recommend preferred voltage ratings and taps for industrial power transformers; and some secondary objectives. The scope of the committee's work was limited to those industrial plants which received power at primary voltages (2,200 volts or higher) or which generate their own power at these voltages. The work was limited to this field in the belief that it represents the largest users of electric power.

In summarizing his digest of the subcommittee's report, D. L. Beeman (M '43) engineer, industrial power section, industrial engineering division, General Electric Company, Schenectady, N. Y., speaking for the committee said "The highlights of this report are that utilization-device voltage-spread have been set at 420 to 480 volts on systems nominally rated at 460 volts; 460 volts has been established as the nominal system voltage. The transformers for supplying these systems will be rated, for example, 2,400/480 volts at no load, with two 0.5 per cent taps and 2.5 taps above normal. These transformers will enable the majority of industrial plants to be served without requiring primary voltage regulators and yet maintain voltage within the spread desired. The conclusions are similar for other nominal systems such as 120, 208, 230, and 575 volts."

Following a protracted discussion on the subject of industrial voltage, W. F. Witzig (A '43) research engineer, electrophysics department, Westinghouse Electric Corporation, East Pittsburgh, Pa., presented a paper "Data on the High-Frequency Systems of Coils," Mr. Witzig discussed various factors which affect coil resistance. His data showed the effects of variation in frequency as well as the effects of variations in material being heated, on the effective insulation of the coil. He determined the frequency resistance of several coils, derived at approximate method for the determination of the resistance of coils wound with flat strap, and also derived a short empirical method for determining the resistance of coils wound with tubing.

"Dielectric Heating, the Measurement of Loss Under Rising Temperature" was discussed by Doctor J. B. Whitehead (F '12, Life Member), past president, Edison Medalist 1941, professor of electrical engineering, Johns Hopkins University, Baltimore, Md. He described a new method which he has developed for the measurement of the dielectric properties of an insulated material progressively as its temperature is being raised by a high frequency field, and presented test data showing that this method, "While not in the 'precision' class, nevertheless, has yielded a very satisfactory degree of accuracy."

"Electric Furnace Practice in Canada" was described by J. L. Balleny (M '47) manager of the industrial heating section, Canadian General Electric Company Ltd., Toronto, Ontario. He pointed out that the availability in Canada of an abundance of low-cost hydroelectric power has encouraged the use of electric energy for metallurgical operations there, particularly operations in which large amounts of power are consumed. "In fact," he said, "today. other types of fuel are being replaced by electric heat where economy of operation is a major factor." He told of an electric annealing furnace capable of handling 32-inch steel strip at feeds ranging from 60 to 400 feet per minute, thicknesses ranging from 0.008 to 0.025 inch; total connected load 1,680 kw in the heating units. He added that "installations of electric furnaces in the aluminum industry in Canada exceed 30,000 kw . . . . various types of electric resistance furnaces are utilized in melting, holding, preheating, annealing, and heat treating aluminum and its alloys." Other installations described include induction heating equipment for forging and hardening, continuous regulation of electric melting furnaces, and alloy steel melting in electric arc furnaces.

"High-Frequency Heating in the Radio Spectrum" was discussed by W. C. Rudd (A '34) chief engineer, Induction Heating Corporation, New York, N. Y. With particular reference to the causes and the prevention of radio interference, he considered induction and dielectric heating, as well as dielectric heating for medical purposes. Mr. Rudd reviewed in some detail the studies that have been made and the actions that have been taken by the AIEE subcommittee on electronic heating in working with the Federal Communications Commission in an effort to guide the development of governing rules and regulations on allowable frequencies, equipment inspection and registration procedure, and other related matters in such a way as to provide for desirable controls without imposing unbearable restrictions upon the manufacturers and users of high-frequency heating equipment. He reported that on May 17, 1945, the FCC announced the following frequency allocation for industrial, medical, and scientific equipment. Item I, 13.66 megacycles. plus or minus 0.05 per cent. Item II 27.32 megacycles, plus or minus 0.5 per cent. Item III, 40.98 megacycles, plus or minus 0.05 per cent.

Among other things, the committee subsequently recommended that consideration be given to the assignment of two additional frequency channels below 13.66 megacycles per second, and also at 500, 1,000, 3,000, 6,000, and 9,000 megacycles per second for further work. Subsequently the FCC announced the allocation of a frequency channel at 2,450 megacycles per second and the widening of the 27.32-megacycle channel through a band ridge of 320 kc per second, making it possible to use reasonably simple equipment for dielectric heating at that frequency, and still maintain the desired frequency stability. Quite recently, the FCC issued a notice proposing additional frequency allocation at 6,915, 5,850 10,600 and 18,000 megacycles per second

Power Transmission and Distribution Featured at Two Sessions

R. J. Wiseman (F '27) chief engineer The Okonite Company, Passaic, N. J., presided over the technical session on power transmission and distribution which was held on Wednesday, June 11. Four technical papers were presented at this session.

ELECTRONIC STABILIZER

A new approach to an old problem—the extension of electric power transmission—was suggested by the paper "Electronic Stabilizer for Power Transmission" by E. F. W. Alexanderson (F '20) consulting engineer, General Electric Company, Schenectady, N. Y., and David C. Prince (F '26), vice-president in charge, general engineering laboratory, General Electric Company, Schenectady, N. Y. Limitations of conventional synchronous power transmission are well known. Voltage regulation of an alternator historically has depended upon variation of the field current, and high speed regulators have been developed in order to improve synchronous stability. The method described by Alexanderson and Prince embodies a voltage control brought about by varying the output current. A reactive load is connected to the generator terminals. This load is varied electronically in such a manner as to maintain the desired voltage and line current. The authors do not presume to make economic or technical comparisons with other known methods of extending a-c transmission. They merely point out that when we add the electronic stabilizer to these other methods, specifically, intermediate synchronous condenser stations and series capacitors, we have three methods which all differ in principle but, nevertheless, may be used in combination.

BREAKDOWN VOLTAGE

"The Probable Breakdown Voltage of Paper Dielectric Capacitors," Hamilton Brooks (M '46) design engineer, Westinghouse Electric Corporation, East Pittsburgh, Pa. In his discussion Mr. Brooks pointed out that one of the more important defects in thin paper installation is conducting particles. It commonly has been assumed that factory test failures and many service failures are the result simply of the alignment of conducting particles in two or more sheets of the paper. A simple mathematical analysis, however, shows that the frequency of short circuits on test and the decreasing dielectric strength with decreasing insulation thickness and increasing area cannot be accounted for satisfactorily by an alignment theory. Another way that variations in dielectric strength and occasional short circuits may be explained is through the chance reorientation of large conducting particles. Mr. Brooks maintains that, if it is assumed that such reorientation takes place so that particles extend into and through adjacent sheets, and if the proper laws of chance are applied, the dielectric strength of capacitors ceases to be an erratic and unpredictable quantity. Furthermore, a basis is established whereby field performance can be anticipated assuming, of course, that the capacitors are normal in other respects.

METERING

In his paper, "Metering With Transformer-Loss Compensators," George B. Schleicher (M '34) technical assistant meter division, transmission and distribution department, Philadelphia Electric Company, Philadelphia, Pa., summed up the results of his experience with compensating meters since 1932, and with the more recent application of transformer-loss compensators. He directed his remarks to electric utility executives and engineers considering the possible advantages of the method for their systems, to guide them in co-ordinating the application of transformer-loss compensators with metering practice.

The application of transformer-loss compensators to metering on the low-voltage side, as compared with metering on the high-voltage side, is advantageous when the metering cost is appreciably lower than for metering on the high-voltage side; for exposed locations on the system, where high-voltage instrument transformer equipment may be expected to be troublesome because of lightning or other disturbances; when the limited available space makes the installation of high-voltage metering equipment difficult, hence more expensive; and when a customer with a rate for low-voltage service is changed to a high-voltage service rate. Generally speaking, metering on the high-voltage side is preferred when multiple compensator installations are necessary in place of one metering equipment on the high-voltage side, where a part of the load is used or distributed at the supply voltage (high-voltage metering is necessary in this instance), and where the cost of high-voltage metering is lower than a compensator installation.

GALLOPING CONDUCTORS

"Galloping Conductors and a Method for Studying Them," E. L. Tornquist (M'42) engineer of tests, and C. Becker, both of the Public Service Company of Northern Illinois, Chicago. In the operation of an overhead electrical transmission and distribution system, galloping of conductors often results in considerable damage to the line and overhead structures. Because of its seriousness, this problem has prompted much study and research by the industry in the hope of finding a practical solution. The galloping effect is produced under a variety of conditions, however, all forms may be found to be susceptible to alleviation by the same means. An experimental line has been constructed which will gallop typically and vigorously in ordinary winds of seven to ten miles per hour and higher velocity. It is the opinion of the authors, based on their various observations, that the oscillations produced in an experimental line of that type closely simulate natural galloping and can be used for the study of remedial measures, even though natural galloping sometimes may be caused by aerodynamic mechanisms different from that which is active in the case of the half-round section. Tornquist and Becker expressed the belief that though the practical solution of the galloping problem is not yet in sight, and probably a large amount of work remains to be done, the hope of finding an answer should be sufficient to justify further work and to encourage others to study the problem.

SECOND SESSION

More than 175 persons attended the June 12 session on power transmission and distribution which was under the chairmanship of I. W. Gross (F'45) electrical research engineer, American Gas and Electric Corporation, New York, N. Y. Various aspects of lightning and its relationship with power transmission was the subject of three of the four papers presented at this session.

WOOD POLE LINE INSULATION

Among the conclusions drawn by P. L. Bellaschi (F'40) development engineer for Westinghouse Electric Corporation, Sharon, Pa., in his paper "Lightning and 60-Cycle Power Tests on Wood Pole Line Insulation," are that the three predominant factors determining the impulse strength of wood are the length of wood, the duration of the impulse, and the moisture content in the wood; that the extent of shattering of wood poles and crossarms from lightning is limited; and that wood possesses distinct power quenching characteristics which, in a measure, now are being utilized with intent by some operators. Mr. Bellaschi reported that since the development of a lightning stroke generator in 1935, nearly 100 distribution wood poles have been tested by his company. These tests, which were made on western red cedar, chestnut, and pine wood poles, indicated that less than a dozen poles in 100 miles of line are likely to suffer damage to any great extent. These laboratory lightning tests further indicated that wood poles of high moisture content shatter with greater ease than dry poles, but that the probability of the wood catching fire is remote, unless the wood is very dry and the stroke severe.

TVA TRANSMISSION LINE

The paper, "Performance of Tennessee Valley Authority 161-Kv and 115-Kv Transmission Lines," K. E. Hapgood (F'44) chief, power engineering and design division, and C. T. Almon, Jr., (M'45) chief, power system operations division, both of the Tennessee Valley Authority, Chattanooga, Tenn., described the design features of 115- and 161-kv lines from a lightning point of view. All the 161-kv and 115-kv lines constructed by the TVA are designed on the principle of the direct stroke theory. Multiple ground wires are used for shielding; counterpoises and ground wires for reducing ground resistance. Separately supported ground wires on separate structures are used in some instances. Data reported by the paper show that a definite decrease in lighting outages is obtained by the use of counterpoise. The record of the 161-kv line is better than the 115-kv line when considering lightning performance. The qualities of a line as related to design and operation must be considered on the basis of the individual line, location, and function. From observation of the operating record of steel tower transmission lines which have average ground resistance at 50 ohms or less, the authors believe that there is little to be gained by installing counterpoise on such lines.

LIGHTNING INVESTIGATION ON A 25-KV SYSTEM

"Lightning Investigation on the 25-Kv System of the West Penn Power Company," William C. Bowen (M'30) assistant electrical engineer, West Penn Power Company, Pittsburgh, Pa.; Edward Beck (M'35) section engineer, switchgear engineering department, Westinghouse Electric Corporation, East Pittsburgh, Pa. This paper reported an investigation of the discharge current in lightning arresters of certain 25-kv substation. The investigation, sponsored by the West Penn Power Company with the co-operation of the Westinghouse Electric Corporation, ran continuously from 1939 to the end of 1945. The investigation included practices in applying arresters on both new and old equipment. Many of the lightning arrester impulse currents measured were of a character which indicated that voltages in excess of equipment strength would have existed if no lightning arresters had been used. Arresters with ratings lower than the system voltages to which they might be exposed had higher failure rates. On the other hand, economics justify the use of reduced voltage rating arresters in special cases to provide maximum protection to old equipment, thereby reducing the risk of interrupting the service to important loads at the risk of an occasional arrester failure.

LONG DISTANCE TRANSMISSION

"Economics of Long Distance A-C Power Transmission," S. B. Crary (F'45) engineer, analytical division, central station engineering division; I. B. Johnson (M'45) assistant engineer, aeronautics and marine division, both of the General Electric Company, Schenectady, N. Y. Based on assumption made by the authors, economics of high voltage transmission showed a minimum cost of energy transmitted at a medium voltage in the general order of 360 kv with the cost increasing. Discussion brought out the fact that the transmission line as a means of transportation of energy has gas and oil as competitors, and data on these costs in various parts of the United States were presented.

Protective Devices Subject of Friday's Session

H. J. Lingal (M'41) switchgear and control engineering department, Westinghouse Electric Corporation, East Pittsburgh, Pa., presided over the technical session on protective devices which was held on Friday afternoon, June 13. The five papers presented at this session covered various phases of protective devices from relay protection of power transformers to performance criteria of d-c interrupters.

RELAY PROTECTION

The AIEE relay subcommittee, under the chairmanship of W. R. Brownlee (M'38) investigation division, Commonwealth and Southern Corporation, Jackson, Mich., presented a report on "Relay Protection of Power Transformers." The report concluded an investiation covering a period of three years. The committee reviewed experience with over 56,000,000 kva of power transformers in order to develop criteria of adequacy of protection. Although this report completes the work of the group, the subcommittee anticipates further developments, both in the design of relay protective devices and in application methods to obtain the objectives discussed in the report. The subcommittee currently is engaged in pursuing a number of other subjects including new working groups appointed this year on electronic relay applications, insulation levels of control circuits, sensitive ground protection, and transmission line protection.

In discussing the report, E. E. George (F'36) Ebasco Services Inc., and F. L. Lawton (M'36) Aluminum Company of

Canada, stressed the need for gas pressure responsive relays in obtaining complete transformer protection. E. L. Harder (M '41) Westinghouse Electric Corporation, pointed out that a complete line of demarcation exists between thermal protection and electric relay protection.

SELECTIVE TRIPPING

In presenting his paper, "Selective Tripping of Low Voltage Air Circuit Breakers," William Deans (F '30) chief engineer, I-T-E Circuit Breaker Company, Philadelphia, Pa., advocated selective or sequential tripping of low-voltage air circuit breakers through a special direct-acting series tripping device on the circuit breaker, which provides long time delay on overcurrent and very short time delay on fault current. The several circuit breakers in series are set so they will respond to overcurrent and to force currents in proper sequence. The mechanism proposed by Mr. Deans for obtaining selective tripping of the breaker consists of two time delay devices, one for short time and one for long time delay, to control the operating time of a common tripping magnet.

SWITCHGEAR

R. G. Lockett (M '37) application engineer and J. D. Wood (M '27) electrical engineer, both of I-T-E Circuit Breaker Company, Philadelphia, Pa., in their paper "A Development in 5,000-Volt Metal-clad Switchgear," described the application of 50 megavolt-ampere and 100 megavolt-ampere 5,000-volt magnetic blowout-type air circuit breakers in draw-out-type switch gear. The authors claim economical use of materials, reduction in space, improvement in circuit interruption, and improvement in insulation levels.

IMPROVED TRIPPING DEVICE

In a paper entitled "An Improved Overcurrent Tripping Device for Low-Voltage Circuit Breakers," H. L. Rawlins (M '41) manager, protective devices engineering department, and Jerome Sandin (M '46) electrical engineer, both of Westinghouse Electric Corporation, East Pittsburgh, Pa., Mr. Rawlins described a tripping unit in which the timing characteristics are obtained by the positive displacement of a silicone fluid in a hermetically sealed chamber. The reliability of the sealed timing element is claimed to be unaffected by temperature changes or atmospheric conditions. Instantaneous tripping on fault currents is accomplished irrespective of any action within the sealed timing element. On currents above the prescribed value, the instantaneous armature is picked up by the flux and lifts the sealed timing element to trip the breaker. Selective tripping is obtained by use of tripping elements selected to respond in different times to a value of tripping force.

D-C INTERRUPTERS

In presenting the paper entitled "Performance Criteria of D-C Interrupters," E. W. Boehne (F '43) assistant professor, electrical engineering department, Massachusetts Institute of Technology, Cambridge; M. J. Jang (A '44) switchgear division, General Electric Company, Philadelphia, Pa.; Mr. Jang said that the d-c interrupters available today were developed by well-proved empirical methods. The authors of this paper claim to have developed a simple straightforward analytical treatment, which, when used in conjunction with present empirical science, should enhance the progress and understanding of the performance of interrupters during the period of their development, and lead to a more accurate formulation of the rules relating to their proper application.

Carrier Current on Power Systems

Taking the place of Philip Sporn (F '30) of the American Gas and Electric Service Corporation, New York, N. Y., who could not attend the technical session on power systems application of carrier current at the summer general meeting in Montreal, was A. S. Runciman (M '35) of the Shawinigan Water and Power Company, Montreal, Quebec, Canada. Mr. Runciman mentioned that the feature which did not come out during the meeting was actual operation of single-side-band equipment. He felt that there must be enough interest in this new principle to warrant a paper on the first operating installation of this type.

A new method of single-side-band generation, working on the frequency-addition principle is described in "A New Single-Side-Band Carrier System for Power Line," by B. E. Lenehan (A '24) of Westinghouse Electric Corporation, Newark, N. J. The present range of frequencies in general use is from 50 to 150 kc, although some use has been made of frequencies from 40 to 300 kc. Extending the band of frequencies may not be the satisfactory solution in all cases, and in some locations, widening the band may be practical, but a better solution is believed to be the use of the single-side-band system. This system requires about half the frequency range per channel required by other systems. Equipment to be used on power lines must be continuously adjustable in frequency which is the basis on which the system was developed.

TVA COMMUNICATIONS

Explanation of the enormous size of the Tennessee Valley Authority communications systems and its independence of the power system was described in "TVA Coordinated Communications System," by T. DeWitt Talmage (M '40) of the Tennessee Valley Authority, Chattanooga, Tenn. The communications and control systems outlined in the paper were developed during the past 12 years, and each constituent part thereof was tested thoroughly for practicability. Reliability of communication is secured on the system by different types of facilities over different geographical paths. Direct communications circuits between key points furnish fast telephone service to important locations. That the types of standardized systems described meet basic requirements is attested by successful everyday operation, one example of which was the satisfactory handling of telephone calls at the rate of 2,5000,000 messages a year.

Some of the more common problems that arise in establishing a reliable carrier channel on a power line were described in "Operation of Power Line Carrier Channels," by H. W. Lensner (A '43) of the Westinghouse Electric Corporation, Newark, N. J. Field tests to determine a satisfactory operating frequency are often necessary, particularly on complex power systems with parallel paths for the carrier energy and short taps on the line which may give serious reflection losses. As power engineers become better acquainted with the behavior of carrier frequencies on their power systems, they will find that they can apply advantageously carriers to more and more of their lines with confidence in its ultimate performance.

Conversion Problems Compared for Electrochemical Industries

A conference covering the electrochemical conversion equipment used in the manufacture of zinc, magnesium, and chlorine, was attended by about 100 representatives of manufacturers and users of such conversion equipment. Arranged by the committee on electrochemistry and electrometallurgy, the conference was held June 12 during the summer general meeting, and T. R. Rhea (A '41) chairman of the committee presided.

The papers were well integrated and profusely illustrated by slides and tended to illustrate common practices and problems encountered in the electric equipment for these three industries.

Mainly, the papers covered the capacities, layout, control, and operation of huge installations of mercury-arc rectifiers and rotary converters in this type of industry, taking 12 to 14 billion kilowatt-hours per year. This is the greatest kilowatt demand of any industry and is notable for its steady 24-hour nonpeaked load.

It, therefore, was considered fitting that the AIEE take recognition of the practices and advances in these important industries.

ZINC

"Electrolytic Zinc at Anaconda" was presented by R. J. Kennard (A '21) of the Anaconda Copper Mining Company, Great Falls, Mont. Prior to the first world war there was a pilot plant for the electrolytic production of zinc which led to the larger plant at Great Falls and a smaller plant at Anaconda.

Originally there was some discussion about the selection of 250 or 550 volts in the tank circuit. Ultimately, 550 volts was used with the mid-point of the tank circuit grounded. Actually, at first this was a menace because of the very low resistance in the grounded lag. The choice of 550 volts was considered fortunate later, however, when rectifiers and rotary converters were operated in parallel.

Static rectifier equipment (mercury arc) has worked out very well in parallel with rotary converters, incurring almost no trouble with arc-backs as was anticipated.

Considerable discussion took place between the author and representatives of the Dow Chemical Company and the Aluminum Company of America on the question of getting the rotary converter in service after shutdown. With zinc tanks, there is a considerable back electromotive force at all times. The Dow Chemical Company always drops the voltage of the rectifier below line voltage with a booster and then brings it up with the rotary converter. This is done to avoid trouble in interconnections involving turbogenerators. When the load is suddenly applied or dumped, governors and so forth, may not react properly. The Canadian practice is actually to shut off the load and re-energize when ready.

MAGNESIUM

Problems presented by the expansion of the magnesium industry for war requirements—as much as 500 per cent for some plants—were discussed by F. S. Glazal (M '46) Dow Chemical Company, Freeport, Tex., in "Conversion Equipment in the Magnesium Industry."

One of the unsolved difficulties of the electrolytic production industry is the accurate metering of direct current. The *L* and *N* "null" method is satisfactory, but meters accurate enough for it cannot be had. D-c output usually is measured with graphic instruments. Also in the *L* and *N* method, capacitance effects must be eliminated to avoid meter errors.

CHLORINE

"Conversion Equipment in the Chlorine Industry," was described by D. O. Hubbard, of the Hooker Electrochemical Company. The production of chlorine during the war was considered third in importance, the order being: aluminum first, magnesium second, and chlorine third. The cost of electricity in the chlorine industry is about one fourth the total and, therefore, economy is an important item.

Chlorine production is the only one of the electrochemical products for which production has increased since the end of the war. The problem of corrosion in the atmosphere around the chlorine plant is a considerable one. In most chlorine installments, the cell circuits are not grounded.

Modulation Featured at Communications Session

H. R. Turner (F '44) associate professor of electrical engineering, Yale University, New Haven, Conn., officiated at a technical session on modulation on June 11 at Montreal. One of the features of the session was a demonstration of various modulation methods by S. M. Findlay (A '40) of RCA-Victor of Canada, Montreal, Quebec.

Certain concepts intended to facilitate the understanding of the various types of modulation were presented in the paper, "Modulation in Communications," by F. A. Cowan (F '45) of the American Telephone and Telegraph Company, New York, N. Y. Amplitude and frequency modulation including phase and time modulation systems are the major classifications. A comparison of modulation systems for determination of the desirable type of modulation or transmission systems was included in the discussion. Many interrelated factors which vary widely with the condition of application are: length of system, relative availability of frequency space, variation of cost of transmission system with frequency band widths, type of signals, ratio of minimum required frequency band to that practically necessary, desired fidelity of performance, and the nature of transmitting medium. Qualifications which are necessary to accompany even these simple generalizations are an indication of the difficulty to determine the appropriate form of modulation for a given set of conditions.

PULSE MODULATION

"Distortion and Band Width Characteristics of Pulse Modulation," by H. L. Krauss (A '42) and P. F. Ordung (A '45) both of Yale University, New Haven, Conn., presented a mathematical method for an exact solution for the spectra of various types of modulated pulse waves. The results are used to indicate relation between parameters such as pulse length, average repetition rate, and maximum allowable time of phase shift of the pulse with respect to their effect on distortion and band width.

An 8-channel transmission system employing pulse code modulation is described in "Pulse Code Modulation," by H. S. Black (F '41) and J. O. Edson, both of Bell Telephone Laboratories, Inc., New York, N. Y. The transmission system described was developed in portable form for field operation. In carrying out this new type of modulation, the speech wave applied to each channel is, in effect, transmitted sample by sample, and each sample is represented by a multiunit code employing on-or-off pulses. According to the authors pulse code modulation appears to have exceptional possibilities from the standpoint of freedom from interference especially when applied to systems having many repeaters in tandem, but its full significance in connection with future radio and wire transmission may take some time to reveal.

Analysis of the distortion and cross talk arising in a pulse count modulation system was described in "Distortion in a Pulse Modulation System," by A. G. Clavier, P. F. Panter, and D. D. Grieg (A '39) all of Federal Telephone and Radio Laboratories, New York, N. Y. The methods of transmitting intelligence by means of short bursts of pulses of energy have shown increasing application within recent years. The discreet nature of such a system introduces a type of distortion which is a function of the number of amplitude levels used. Discussion was limited to the so called video or d-c pulses without regard to the specific method of radio-frequency transmission. The method of the Fourier transform was introduced in order to cope with the more formidable problems of analysis of pulse code modulation applied to a large number of modulating signals. Results of the commutation indicate that accepted standards of telephone transmission over wire and radio commercial systems can be obtained with a relatively small number of levels.

COMMUNICATIONS SESSION

The communications session on June 12, 1947, at Montreal, ranged from the oldest form of electrical communication to the newest—from telegraph to television. There was a lively discussion which touched upon the relative merits of frequency modulation and amplitude modulation for telegraph and the need for regenerative repeaters. In the discussion following the talk on radio interference in Canada, potential producers of radio interference testified to the success of that approach to the problem. J. J. Pilliod (F '34) American Telephone and Telegraph Company, New York, N. Y. presided at the meeting.

A few arrangements devised for automatically retiming and retransmitting teletypewriter signals as originally designed for use by the Armed Forces were described in "An Electronic Regenerative Repeater for Teletypewriter Signals," presented by R. B. Hearn, Bell Telephone Laboratories, Inc., New York, N. Y. The electronic regenerative repeater correctly interprets the distorted pulses received and retimes them so that the signals retransmitted are timed substantially perfectly. The *TG-29* repeater was designed for portable use on whatever type of power supply was available. Thus the size and weight of the unit was greater than is necessary for central office use. In spite of the satisfactory performance of the unit it was never put into production because mechanically regenerative repeaters were already available. There are several advantages which will be gained by the use of the electronic device which are: freedom from mechanical maintenance, freedom from lubrication difficulties, ability to operate at lower temperatures than is practical with mechanical units, stability of operation over long periods at high speed, and easy adjustment for different operating speeds or codes.

FM TELEGRAPH TERMINAL

In "A Frequency Modulation Telegraph Terminal Without Relays," by F. H. Cusack and A. E. Michon (M '47) both of The Western Union Telegraph Company, New York, N. Y., the circuits employed were described and application information was given. Development of this new carrier telegraph channel terminal has provided an improved type of equipment which already is finding widespread application in the Western Union system and is expected to appeal to many other users. A high grade of transmission efficiency has been achieved by taking full advantage of the superior performance obtainable through the use of frequency modulation. Operation of d-c leg circuits electronically was included in the development. Equipment complexity was minimized, operating maintenance procedure was simplified, and savings in space were affected by concentrating supervisory functions in a central location and by reducing types of leg operation.

"The Application of Heterodyne Modulation to Wide-Band Frequency-Modulated Television Relays," by W. P. Boothroyd, Philco Corporation, Philadelphia, Pa., described the heterodyne method of remodulation to meet the requirements that a television relay system be capable of handling, with excellent fidelity, the signal frequency range from 30 cycles to 5 megacycles, and that the signal-to-noise ratio, after multiple relaying, be superior to commercial television broadcast standards. The first terminal equipment of the design described has been operating for field tests over a period of months without adjustment since the initial installation. Only two controls are intended for the operator's use which are the power switch and the input level (gain) control so that normal deviation may be obtained with a plus or minus 25 per cent video signal input level tieline. This performance has satisfied those connected with this work with the feasibility of heterodyne remodulation for radio relay systems in general and of this particular wide band television relay.

INTERFERENCE SUPPRESSION

Methods of measurement and tolerable limits of interference from various electric sources were dealt with in the paper, "Radio Interference Suppression in Canada," by H. O. Merriman, Canadian Department of Transport, Ottawa, Ontario, Canada. In Canada the density of population is low and it is not economically feasible to establish the number of broadcast stations which would be required to provide a high field strength for all potential listeners. However, the level of natural static due to atmospheric disturbances is relatively low, and man-made interference is of great importance, therefore definite action to control such interference is imperative. The various types of interference dealt with were that from street railways, power lines, motor vehicles, appliances, radio frequency generators (industrial and medical), and communications systems. The Canadian Standards Association is preparing a series of specifications establishing methods of measurement and tolerable limits of radio interference, and the American Standards Association is dealing with many phases of measurement and control. Although the commercial user of radio communications is well aware of the limitations of his equipment and the impossibility of affording full protection to the weakest signals, much remains to be done in educating the user of home receivers. The average broadcast listener and television fan does not realize yet how much his enjoyment is dependent on the proper installation of equipment, suited to his particular location and needs, and fed by a skillfully erected antenna.

The last paper, "The Telephone System in Canada," by J. L. Clarke (M '30) of Bell Telephone Company of Canada, Ltd., Montreal, Quebec, was of the conference type. It contained a brief description of Canada's telephone system. With a population distributed rather thinly over a vast area, there are special problems in providing telephone service. These have been solved to create an outstanding telephone system.

Servomechanisms Session Covers Wide Range of Subjects

About 45 relatively younger members attended the servomechanisms session Wednesday afternoon, June 11, 1947. The sesson showed a wide range of servomechanism subjects, with emphasis on systems thinking integrating the fields of power, machinery, electronics, measurements, mathematics, hydraulics, and mechanical engineering. Chairman Gordon S. Brown (A '33) presided at the session.

ELECTRICAL ANALOGY

One of the two theoretical papers on the subject was "Solution of the General Voltage Regulator Problem by Electrical Analogy," E. L. Harder (M '41), Westinghouse Electric Corporation, East Pittsburgh, Pa. The major portion of the paper was abstracted from a thesis, having the same title, by E. L. Harder, submitted to the University of Pittsburgh in partial fulfillment of the requirements for the degree of doctor of philosophy, June 1946. The paper reviewed the problem of the transient performance of a generator voltage regulating system, following a voltage disturbance or a sudden addition of load. The general quantitative solution to this problem was given, having been obtained by means of the servo-analyzer, an analogue type of computer for analyzing regulating systems. The paper reviewed the problem, described the servo-analyzer method of solution, and gave the general solution with interpretations.

The other theoretical paper was "The Analysis and an Optimum Synthesis of Linear Servomechanisms," Donald Herr (M '47) and Irving Gerst, both of Control Instrument Company, Inc., Brooklyn, N. Y. The concepts of minimum bandwidth and non-minimum bandwidth servomechanisms were introduced. Only minimum bandwidth servomechanisms were dealt with in the paper. A systemized approach to the synthesis of such servomechanisms was outlined and the method applied and detailed results obtained for one practical class of such servomechanisms. An engineering criterion of servomechanism stability was discussed.

Both of these theoretical papers, of special interest to designers and academic people, provoked a lively discussion covering an interest in a wide number of engineering problems.

POSITIONING SYSTEMS

One of the two applications papers (both of which were conference papers) was "High-Accuracy Electrical Positioning Systems for Industrial Use," by D. E. Garr (M '45), General Electric Company, which cited applications of servomechanisms, and the form of components commonly used in industry. The paper described a positioning system which, accurately, rapidly, and with suitable power amplification, will position a power mechanism in accordance with information from a remote station. The system discussed was an all-electric one, which made use of selsyns, vacuum tubes, an amplidyne, and a d-c motor.

RECORDERS

The other applications paper was "Self-Balancing Recorders as Servomechanisms," A. J. Williams, Jr. (M '42), chief of the electrical division of the research department of Leeds and Northrup Company. This paper pointed out that self-balancing recorders, though generally not servomechanisms, do embody problems such as damping and filtering which are very similar to some of the problems encountered in the design and operation of servomechanisms. A few recorders were described as to operation and application with emphasis on the attack of these common problems. These two papers also had a good discussion from the floor.

Three Devices Described at Instruments and Measurements Session

At the technical sessions on instruments and measurements on June 12, 1947, Joseph Zamsky (A '43), Allis-Chalmers Manufacturing Company, presented a paper on "Quantitative Determination of Magnetic Properties by Use of Cathode-Ray Oscilloscope" in which he described a new embodiment of an old principle for magnetic measurements. The device avoids errors and uncertainties resulting from air gaps and corner effects inherent in previous methods of core-loss measurement. The question of the extent to which eddy-current losses are included was raised by Mr. Richter, and numerous questions from other members brought out interesting points regarding the accuracy and significance of the results.

ELECTRODYNAMIC APPLICATIONS

N. P. Millar presented a paper on "Applications of the Electrodynamic Instrument Mechanism," by A. J. Corson (M '43) and N. P. Millar (A '44), both of General Electric Company. This paper described methods for utilizing the inductive characteristics of the electrodynamic instrument mechanism which in many usual instruments is considered a complication to be minimized or compensated. Through use of the mutual inductance, measurements can be made of a large variety of variables such as frequency, temperature, pressure, and displacements.

CAPACITANCE BRIDGE

A paper "A Self-Balancing Capacitance Bridge" by A. H. Foley (A '41) General Electric Company, described a device that has the convenience of a capacitance meter with the accuracy of an ordinary capacitance bridge, yet overcomes the time limitation of the latter by a scheme of automatic balancing. In the use of the bridge a nominal value for an unknown capacitance is set manually on dials and the instrument shows within an average time of two seconds the deviation in per cent of the actual value from the nominal. Numerous practical refinements in mechanical and electrical design were described by the author. Discussion brought out the reasons for the choice of the method and additional features of the instrument.

KLYDONOGRAPH

J. H. Waghorne, Hydro-Electric Power Commission of Ontario, in a paper "A Simplified Double-Film Klydonograph with an Improved Coupling Method," described a simple, inexpensive device for studies of surges on transmission line caused by switching, lightning, or other disturbances. It is a practical design for outdoor use on lines of any voltage, the range being changed by a simple choice of accessories. It is a double unit so as to record both positive and negative surges and to identify the polarity. Radioactive material imbedded in engraved indentifying numbers is used to mark the photographic film while it is in the instrument.

Four Papers Presented on Industrial Control Devices

The session on industrial control devices was held Thursday morning, June 13, 1947, E. H. Alexander (M '43), presiding. Three papers on motor controls, and one on a magnetic amplifier were presented.

DYNAMIC BRAKING

The problem of obtaining dynamic braking automatically in the event of power failure was discussed for 2-motor drives in a paper titled "Dynamic Braking of Two D-C Series Motors" by John D. Leitch (M '42), Electric Controller and Manufacturing Company. Various methods of connecting the two motors were considered from the point of view of service requirements.

SLIP RING MOTOR CONTROL

Another paper on the subject of motor control was "Control of Slip Ring Motors by Means of Unbalanced Primary Voltages" by N. L. Schmitz (A '43), Cutler-Hammer, Inc. This paper presented a method of obtaining suitable speed torque characteristics for application such as hoists, draw benches, and other similar machines. The behavior of an induction motor with secondary capacitance was analyzed by developing a more general equivalent circuit and correlating the primary current locus to the conventional circle diagram.

STABILITY REGULATORS

The final motor control paper was called "Rotating Stability Regulators for Synchronous Motor Drives", by W. Schaelchlin (M '46) Westinghouse Electric Corporation. This paper described the performance of the rototrol stability regulator as applied to ship propulsion for tankers and troop ships, and which has proved equally successful for other drives such as model motor drives associated with wind tunnels, steel mills, and hoists.

MAGNETIC AMPLIFIERS

The other control paper in this session was: "Some Fundamentals of a Theory of the Transductor or Magnetic Amplifier" presented by A. Uno Lamm (A '35), Allmanna Svenska Elektriska. The combination of the d-c presaturated reactor and the metallic rectifier was treated with an idealized magnetization curve as a basis. Two typical connections were chosen as examples, namely, one polyphase connection without self-excitation and one single phase connection with self-excitation. The behavior of this combination is very similar to that of grid-controlled rectifiers. It was pointed out that there is a marked difference as to the dynamic properties of the two connections, and that much more rapid response is obtained at correct design than generally expected, making the application to quick acting regulators often quite possible. The author used the term "transductor" for a d-c presaturated reactor, this usage being common in Scandanavian countries.

Demonstration Highlights Conference on Telemetering

The conference session on telemetering held on June 13 in Montreal was attended by about 70 persons to hear the five conference papers and one technical program paper presented. At least two of the five conference papers probably will form the basis of formal papers to be submitted for presentation at a later AIEE national meeting according to G. S. Lunge (A '23) of General Electric Company, Schenectady, N. Y., who presided at the meeting.

A development which started as an attempt to replace mechanical relays with electronic tubes is described in "Electronic Telemetering Systems" by G. E. Foster (A '32) Foster Engineering Company, Chicago, Ill., and W. M. Kiefer (A '39) Commonwealth Edison Company, Chicago, Ill. A telemetering system for transmission and totalization of megawatt readings which would have as slight an error as possible was desired. Previously existing impulse systems used relays, impulse motors, and commutators to provide a converter of kilowatts to impulses, impulse totalizer, transmitter, receiver, and converter and recording instrument for converting impulse rates into a reading. An electronic system reduces the number of moving parts, friction, and inertia, and thus provides an excellent approach to an impulse system. The system using impulses generated, totalized, and indicated by electronic methods was developed which has an error of less than one-half per cent and is reliable and consistent.

The conference paper, "The Electronic Impulse Totalizer," by G. E. Foster was illustrated by a demonstration board on which were mounted eight neon lamps in a circle and enough gas-filled and other tubes to reproduce visibly the principal circuits used in the electronic impulse totalized described in the paper. The other conference papers that were presented were: "Telemetering Applications on Systems of Hydroelectric Power Commission of Ontario," by C. K. Duff (M '41) of the Hydro-Electric Power Commission of Ontario, Toronto, Canada; "The Self-Balancing A-C Bridge in Impulse Duration Telemetering," by G. M. Thynell (A '42) of The Bristol Company, Waterbury, Conn.; "New Devices Derived From a Torque Balance Telemeter," by W. H. Burnham, General Electric Company, Lynn, Mass.; and "A Variety of Telemetering Applications," by A. P. Peterson (M '45) Control Corporation, Minneapolis, Minn.

Electric Machinery Subject of Two Sessions

A group of interesting papers on electrical insulating materials, motor design, and transformers were presented at two sessions sponsored by the AIEE electric machinery committee, presided over by M. S. Oldacre (M '42), Friday morning and afternoon, June 13, 1947. The first paper, by H. P. Walker of the Bureau of Ships, outlined experiences and practices of the Navy in using silicone-treated insulating materials for motors, generators, and transformers. The experience so far indicates that temperatures about 100 degrees centigrade higher than for the usual insulations probably will be satisfactory. The data in the paper support the recommendations of hot spot temperatures for silicone-treated insulation which recently were adopted by the Standards committee.

A report on life of insulation by the AIEE transformer subcommittee was presented by V. M. Montsinger (F '29). A summary was given of a co-operative test of the life of class *A* insulation under controlled laboratory conditions. Under the test conditions there was a continual decrease in tensile strength of the insulation instead of an initial decrease in strength and then constant strength for an indefinite period. There is still a question of the effect of allowing or of not allowing the products of decomposition to escape from the test cell.

Mr. Madill (A '41), Aluminum Company of Canada, reported experiences with gas pressure relays for protection of large transformers. Numerous instances were cited where such relays had disconnected faulty transformer before serious damage had occurred. However, several discussers pointed out some objections to the use of such relays instead of the usual differential relays.

T. D. Yensen (M '23) and J. K. Stanley reported the developments of a new cobalt-iron alloy that can be used at high magnetic densities. Such material will be valuable in devices to be installed in airplanes where weight saving is of enough importance to justify the use of high cost material.

The remaining three papers on motor design by R. C. Robinson (M '45), Electric Specialty Company; A. C. Beiler (A '47) and P. L. Schmidt (A '47), both of Westinghouse Electric Corporation; and C. J. Herman (A '44), General Electric Company; and one on transformers by M. B. Mallett (M '37), English Electric Company of Canada, Limited discussed developments in those fields and were of considerable interest to machine designers.

Hydroelectric Power Generation in Germany and Canada Discussed

Three papers on Canadian hydro-electric power subjects and one on the German electrical utility industry during World War II comprised the session on hydroelectric power generation, which was held Thursday morning, June 12, 1947, A. H. Frampton (F '45), presiding.

MAINTENANCE

A number of problems incurred in operating and maintaining the systems of the Hydroelectric Power Commission of Ontario were discussed in a paper called "The Maintenance of Hydroelectric Generating Units" by A. S. Robertson (M '21) and R. O. Standing, both of the Hydro-Electric Power Commission of Ontario, Canada. The examples cited were drawn from a fund of knowledge gained through some 40 years of operating experience of the power commission's systems which comprise nine major hydroelectric stations together with 45 small plants, totaling in capacity more than 1,500,000 kva. A portion of the paper was devoted to the practical aspects of the operation of thrust bearings. Other sections considered the description of several unusual maintenance and repair problems, solutions to which involved the application of novel methods of electric heating, drying out processes, electric welding, and so forth.

A comprehensive picture of hydroelectric power developments, transmission, and power loads in the Province of Quebec, Canada, was presented in the paper called "Hydroelectric Power Development in Quebec," by F. L. Lawton (M '36), Aluminum Company of Canada, Limited. A number of the unusual features of Quebec's unique power developments were described, including the notable Beauharnois, Isle Maligne, and Shipshaw developments; the Montreal 120-kv cable; and the 220/165-kv series transformers forming the essential tie between the Saguenay and Shawinigan systems.

A. H. Frampton (F '45) and G. D. Floyd (M '28) presented a paper entitled "Factors in the Economic Supply of Energy in Hydroelectric Systems." Both these men are with the Hydroelectric Power Commission of Ontario, Canada. This paper reviewed those factors which effect the economics of energy generation (as distinct from peak generation) in the system deriving its supply predominantly from hydroelectric sources. It discussed factors in the design, operation, and load of hydroelectric power systems. Storage problems, efficiency of plant arrangement, operation of units in a single plant and also of units in plants operating in parallel, the effect of load and frequency control and of maintenance schedules, seasonal variations, type of customer contract, load building, and secondary energy generation were some of the factors considered.

GERMAN ELECTRICAL UTILITIES

An interesting paper entitled "The German Electrical Utility Industry During World War II" by John G. Noest (M '36), Consolidated Edison Company of New York, Inc., was presented. This paper pointed out that, although the German electrical utility undertakings had facilities for nationwide interconnections, and although they had a well co-ordinated operating organization, the utilities did not succeed in nationwide interconnected operation, mainly because of technical limitations. Though Germany entered the period of the war with percentages of spare capacity similar to those of the United States, it began to feel capacity shortages as early as 1940. Except for the rapid development of air circuit breakers, development in design and construction of plant facilities progressed in general along similar lines as the United States, although with somewhat less regard for reliability. It also was pointed out that the collapse of the German electrical utility system was coincidental rather than contributory to the general industrial collapse of Germany toward the end of the war.

Mercury-Arc Applications Analyzed for Three Industries

The conference on operation of mercury-arc rectifiers reversed the order of the "industry highlighting" type of conference and treated the use of one piece of apparatus—the mercury-arc rectifier—in various industries. L. W. Morton (M '45) of the General Electric Company, Schenectady, N. Y., presided at the conference which was held June 13, during the summer general meeting under the auspices of the subcommittee on electronic power converters.

The use of the mercury-arc rectifier in the electrochemical, steel, and coal mining industries was discussed thoroughly. These industries represent diversified loads characterized by:

Electrochemical Industry: Steady 24-hour load, high demand.

Steel Production: High peak loads.

Coal Mines: Long distance between source and use.

As mentioned for the electrochemical conversion equipment, no difficulty has been experienced either in steel production or coal mining in operating rotary converters and mercury-arc rectifiers in parallel.

In conclusion, all agreed that, industrially speaking, the mercury-arc rectifier was successful, highly efficient, and versatile. Many more improvements are necessary, however. Considerable study is taking place on the subject of replacement of bulbs and flash-back characteristics.

Conference Held on Computing Devices

A conference on large-scale computing devices was held during the summer general meeting on Friday, June 13. It was under the chairmanship of C. Concordia (M '37) central station engineering department, General Electric Company, Schenectady, N. Y.

The two computing device papers presented were conference papers. They were: "The Bell Laboratories' Relay Digital Computer and Its Use for Solving Their Engineering Problems," by H. W. Bode (M '41), research mathematician, and E. G. Andrews, both of Bell Telephone Laboratories, Inc., Summit, N. J.; and "Engineering Applications of IBM Equipment," by A. W. Rankin (M '45) turbine generator engineering division, General Electric Company, Schenectady, N. Y.

Position of Resistance Welding Reviewed at Conference

A film, "This Is Resistance Welding," introduced that subject to the conference on power supply for resistance welding held June 12 at the summer general meeting. E. A. Vedder (M '35) of the Westinghouse Electric Corporation, Buffalo, N. Y., presided at the conference which attracted about 50 members.

The film, which was shown, through the courtesy of the English Electric Company, depicted the principal types of resistance welding machines, together with varied applications displaying particular advantages and capabilities of each important type.

The first of the three conference papers to be presented was "The Future of Resistance Welding in Canada," by W. W. Brumby, of the English Electric Company. His paper covered the following aspects of resistance welding:

1. What resistance welding has contributed in production of fabricated parts in ferrous and nonferrous metals in many industrial applications.

2. What has been done to overcome difficulties and improve conditions generally by co-operation of welding machine manufacturers, industrial users of resistance welding machines, power companies, and electronic control manufacturers.

3. Resistance welding research now in progress.

4. Problems which developed, how they were overcome, and which of these is now confronting the Canadian industry.

Mr. Brumby further cited numerous instances among United States manufacturers in which installation and resistance welding equipment had effected economies of production and increased production.

"One has only to consider," he said, "such products as domestic refrigerators, ranges, and washing machines, for all of which resistance welding not only has secured increased production and volume of sales, but also has increased or brought about additional power load and revenue for power companies."

Mr. Brumby's specific reasons for maintaining that resistance welding speeds up production and lowers manufacturing costs:

1. Production is much faster.
2. Fabrication is easier.
3. Distortion is at a minimum.
4. Operation is simpler.
5. Less material is used.

This results in better products, he said, because

1. Appearance is improved.
2. Weight is reduced.
3. Quality is uniform.

In his paper, "Serving a 250-Kva Steam Welder From a Rural System," W. R. Mackay, of the Shawinigan Water and Power Company, emphasized that much of the welding equipment being installed in Quebec on the Shawinigan line will be on a relatively weak feeder. Hence, he expects much difficulty with light flicker. In making these installations, approximately 300 kva of series capacitors are being used to correct the power factor to unity.

The importance of a planned distribution system was emphasized by T. J. Holme, of the Canadian General Electric Company. Several alternative factory distribution systems were described, which provide power distribution with minimum voltage variation resulting from the plant loading itself.

Discussion of the three papers indicated that the most serious problems of power supply result from one or very few welders connected to a weak power system. As a result a pulsating load can affect seriously large blocks of lighting loads. A single installation of a large number of welders provides enough diversity to minimize the light circuit problem.

It was established that there is no panacea for all power supply problems. Rather, a study of the economics of each case must be made to decide the most effective solution at the most moderate costs.

Conference Explores Methods of Dissipating Static Electricity

The hazards of static electricity were described as growing increasingly serious under modern working conditions in operating rooms and in grain handling and packing plants at a conference held June 12, during the Montreal summer general meeting, at which Robin Beach (F '35) presided. One conference paper and two technical papers were devoted to the subject. A paper by J. T. W. Babcock of the Factory Insurance Association, considered the hazards of static electricity with relation to explosive vapors; another by C. M. Park, of the Mutual Fire Prevention Bureau, discussed grain handling and grain processing plants; the final paper of the session by H. B. Williams, M. D. (M '41) of Columbia University, described conditions in hospital operating rooms conducive to the generation of static electricity.

According to Doctor Williams, the danger of explosions in operating rooms was minimal with early crude methods of administering anesthetics. However, with the use of pure oxygen as a diluent and with the use of rubber bags and tubing, explosions occurred more frequently. Eventually these were traced to sparks from static discharges, either in the immediate vicinity of the patient's face or within the apparatus itself. When ether vapor is used, the propagation of an explosion can be prevented by metal gauze, as in the Davy lamp. With other anesthetics, cyclopropane and ethylene, the velocity of the explosion wave is so great that this device is ineffective.

To diminish this risk, Doctor Williams recommended keeping all personnel and equipment at earth potential. This entails the maximum use of conductive material in the operating room: floors to be of conductive material in connection with ground, personnel to wear shoes with conductive soles, all furniture to be of metal in conductive connection with the floor, and the anesthesia apparatus to be made entirely of conductive material. However, the anesthesia machine itself is the weak point in this scheme. Coating the rubber of the face mask and supplier tubes with carbon black to make it highly conductive usually renders it so stiff as to be useless. Some success has been achieved by coating these parts with a thin conductive layer, but this layer loses its conductivity rather soon, and daily testing is necessary.

Rubber flooring has been found to be most satisfactory. Floors of terrazzo at first were thought to be safe, Doctor Williams added, but in very dry weather they develop a high surface resistance. The practice of mopping tile floors with four per cent calcium chloride solution to make them conductive also has been followed. In dry winter weather, this too becomes ineffective.

In conclusion, Doctor Williams described a method which has been developed to determine the minimum energy required to explode a stoichiometric mixture of cyclopropane and oxygen.

In the paper by Mr. Park, field investigations to determine the prevalence of sources of state electricity in grain and milling properties were described. The investigations revealed evidence of static electricity in wheat being discharged from bucket elevators and on the metal buckets of the elevators. It was found on metal lining of wood spouts and on ungrounded metal bins and hopper. Ungrounded metal dust collectors in several cases also were heavily charged. It was disclosed that practically all leather and rubber belts were generating static, and rubber v-belts were particularly active generators.

Especially significant was the fact that ungrounded belt guards and similar metallic masses in close proximity to belts tended to accumulate charges of static.

In unheated grain elevators, generation of static electricity was much less noticeable. During periods of low atmospheric humidity, however, it has been possible to detect static in grain stream, on ungrounded metal spouts and hoppers, and on ungrounded metal dust collectors, and sections of metal ducts handling dust-laden air.

Two principal hazards are associated with static electricity in grain and milling plants. The first is the danger of personal injury which may result when an employee subjected to a shock from a static discharge jumps back into a belt or machine and is seriously injured. The second hazard is the possibility that combustible dust may be ignited by a static discharge. Where dust is suspended in air, such ignition can cause a dust explosion and serious fire loss.

Humidity control was recommended by Mr. Park as the most effective general method of protecting flour mills from static electricity. He noted that air-conditioning equipment was becoming increasingly popular in such mills before the war.

Humidity control, however, is not practiced in grain elevators or in feed mills. He predicted an increasingly worsening problem of static electricity in feed mills, which until recently had been unheated and therefore free from the low relative humidity associated with artificial heat. Recent demands for heat from employees have led mill operators to install heating equipment, and the hazard of static electricity may be expected to increase.

Where relative humidity frequently falls below the safe lower limit of 50 per cent, the only effective protection against static is grounding, Mr. Park declared.

After the presentation of papers, the meeting was open for discussion from the floor. The session was well attended and discussions were interesting, pertinent, and vigorous.

Comments were interjected by Professor Beach on recent airplane catastrophies which were directly attributable to electrostatic causes, including loss of airplane location by obliteration of radio communications and flight instruments and, also, airplane explosions originating from electrostatic sparks in the crank cases of engines and other enclosures containing inflammable mixtures of gasoline vapors.

There was no disagreement with Doctor Williams' determination that, under hospital operating conditions, 375 volts is the minimum static voltage likely to ignite explosive mixtures; nor with his deduction that the conductivity of the path for dissipating static should be in the neighborhood of one reciprocal megohm.

It was pointed out that this order of grounding resistance is preferable to low resistance grounding in order to obviate the hazard of electric shock in the use of low voltage (110 volts) equipment.

The conductivity of "conducting rubber" is far from constant and may decrease greatly under conditions of use, it was noted.

Conductivity of the various floor materials was discussed. Ordinary dry concrete tile, terrazzo, and linoleum all have high resistance unless treated. Metal turnings or other conducting materials embedded in the surface layers of concrete are effective in reducing its resistance.

High humidity, alone, may not be effective in dissipating static; when the air contains no carbon-dioxide, the moisture on surfaces may be insufficiently conductive to drain off the electricity as rapidly as it is generated.

Considerable discussion as to conductivity between rotating shafts and their bearings came as a result of the papers by Park and Babcock. In grain processing plants, the stated experience showed no accumulation of static on shafting.

Contrary opinions were expressed concerning shafting under other conditions. One discusser was of the opinion that there is continual metallic contact between shafting and bearings at minute spots and that, therefore, conductance is relatively high, despite the oil or grease. Other discussers, however, were firmly of the opinion that conductance of such bearing joints is so low that very heavy accumulations of static on shafting occur under many conditions. Several such instances were cited, including aircraft engines and crankshafts, in which bearing surfaces showed definite evidence that sparking between shaft and bearing had occurred in almost all cases.

Generation of static by streams of vapors, such as steam, and of finely divided solids such as carbon-dioxide snow and sand or dust were cited. Instances were given in which such static accumulations were so rapid as to result in sparks which ignited explosive mixtures of vapor and air.

Mr. Babcock's statement concerning dissipation of static by the use of radioactive substances for making the air conductive were discussed. Opinion was expressed that the resultant increases in conductivity of the air is sufficient for cases where generation of static is comparatively slow, but not where the generation is rapid.

Others discussed problems of electrification of rubber-tired vehicles, radio antennas, and high-voltage transmission lines occurring from sand and dust storms throughout Western and Southwestern areas of the United States.

Various methods of control of electrostatic hazards were considered, including the high-voltage ionizing units, radium and polonium ionizers, humidification, and the many discarded and impractical varieties of ionizers, such as tinsel, gas flames, needlepoint combs, and jewelers wire.

24 Committee and Subcommittee Meetings Scheduled on Summer Program

The following reports have been received from a number of the committees which convened during the week of June 9–13, in Montreal. Among the other committees which met during the week were: land transportation, general systems, automatic stations, transformer, induction machinery, co-ordinating committee of industry group, electric welding, electronic power converter, electric machinery, electronics, nucleonics, power generation, and electrolytic processes.

EDUCATION

The committee on education at its meeting, Monday, June 9, passed the following two resolutions aimed at improved student relations and instructed its chairman to pass them on for presentation to the board of directors.

1. That Student members of the Institute be allowed all the privileges on purchase of publications which are given to other members.

2. That the "Bibliography of Electrical Engineering," by Professor T. J. Higgins (M '46) be published by the Institute and that a copy be supplied free of charge to engineering schools. Remaining copies to be sold to members and the public.

In presenting the first resolution, the committee on education expressed its awareness of the financial problem involved, but it also expressed deep concern with the relationship of the Institute to its greatest source of membership, namely the college student. It was brought out at the Montreal conferences that about 1,100 new names were added to the AIEE in the last year, and Professor Tarboux noted that the colleges of the country must turn out more than 3,000 electrical engineering graduates annually, of which only a small percentage transfer immediately into AIEE membership.

The second resolution dealt with a project which has been before the committee on education for some time. The committee has considered it over a long period and is convinced that it is a service to the colleges of the country that should be undertaken by the Institute. This bibliography recently has been referred to the publication committee for further appraisal. However, the committee on education emphasized its own pre-eminent qualification to judge the worth to the student of such a bibliography.

A thorough discussion of a proposed series of articles on basic science also took place. A tentative outline of 11 or 12 topics was adopted for circulation to all committee members for suggestion and comment. The list then will be reworked by the chairman with the view of securing an editor who will direct the project and obtain the co-operation of the writers.

J. G. Tarboux (F '43) chairman of the committee on education, presided at the Montreal meeting.

METALLIC RECTIFIERS

Four sessions of the subcommittee on metallic rectifiers were held during the summer general meeting—two June 9 and two June 10—at which L. O. Grondahl (M '42) chairman of the subcommittee presided. Sixty-five per cent of the committee members attended the sessions.

The standard definitions were approved and will be sent to the AIEE Standards committee for final action. Copies of the standards also will be furnished the ASA *C42* committee for inclusion in the revision of the AIEE manual, "Electrical Definitions."

Review of the new test code was completed, and the code was returned to the working committee for additional changes.

Doctor A. U. Lamm (A '35) of Sweden, exchanged information on Swedish practice and attempts to formulate standards. It was learned that there is only one manufacturer of the rectifiers in that country, which greatly facilitates standardization efforts.

A session, devoted to at least four papers—one to celebrate the 20th anniversary of the copper-oxide rectifier—is planned for the 1948 winter general meeting.

SERVOMECHANISMS

The merit of having the scope of its work broadened to "closed-loop control systems" was the principal topic of discussion at the meeting of the joint subcommittee on servomechanisms held Tuesday, June 10. G. S. Brown (A '33) chairman of the subcommittee, presided.

It was thought that the term, "servomechanisms," carried too narrow an interpretation of positional followup, and a proposal to recommend the change to the sponsoring committees was adopted. The committee then agreed to proceed with group action on terminology and definitions covering closed-loop systems.

STANDARDS

The Standards committee meeting, held June 11, was opened at 2 p.m. by Chairman W. P. Dobson (F '43) with a total of 24 executive committee members and representatives from various standards subcommittees and AIEE delegations on ASA sectional committees.

Among the many routine matters dealt with, the following actions were of special interest. Attention was called to the existence since 1941 of a printed pamphlet report on "Standard Basic Impulse Insulation Levels," developed by a joint committee of AIEE–Edison Electric Institute–National Electrical Manufacturers Association. The report is the result of ten years' study and specifies basic levels in terms of a withstand voltage for a specified test wave. Though the values established in the report are intended to be the basis of other standards, it was thought that the 1941 report now should be revised by the joint committee, brought up to date, and its availability given wide publicity. The importance of this last point was stressed particularly, as the existence of the present joint report apparently is unknown to many who could make good use of it.

The automatic stations committee presented a report from a working group concerning proper polarity of d-c control connections. As the result of a widely circulated questionnaire, the automatic stations committee is recommending that the AIEE standardize on the negative polarity connection of d-c control coils. The data contained in the report will be condensed for publication in *ELECTRICAL ENGINEERING*.

A number of years ago the Standards committee requested that the technical committees consider the development of a series of test codes. Many such codes already have been completed. The committee on instruments and measurements now is presenting the "Master Test Code for Temperature Measurement of Electric Apparatus." Before any action is taken on this code, it was agreed, it should be referred to various groups—rotating machinery, transformer, and cable groups—men who are engaged in testing in the field, or, as one man put it, "the heat run men." The comments and suggestions thus obtained should prove of great value in making the code universally applicable.

Doctor W. A. Lewis (F '45) reviewed the status of the current controversy with regard to the sign of the reactive power that has elicited the many comments recently published in *ELECTRICAL ENGINEERING*. No final action was taken, but Chairman Bergvall (M '41) will draw up a final report based on the comments received. The question likewise will be referred to Sectional Committee *C42*, "Definitions of Electrical Terms."

As the closing item, Chairman Dobson reviewed the conference on international standardization held Tuesday afternoon, June 10. It was the consensus that every effort should be made to have the papers that were presented rewritten in a form worthy of publication. If this can be accomplished, they will serve as effective aids to international standardization, it was said.

COMMUNICATION

Report of the committee on communication which met June 12, has been prepared by H. I. Romnes (A '41) secretary of the committee.

A session on underwater sound systems has been in preparation for more than a year, and the San Diego meeting presents a perfect setting for the presentation, in view of its Naval activities. It was agreed that this topic would be the theme of the communications program at the Pacific general meeting. It is probable that a full day will be devoted to the subject.

For the Midwest general meeting, it was agreed that two communications sessions would be the objective. One would cover several specific applications of various methods of modulation; the other would be built around radio systems. These sessions will be co-ordinated with the program of the National Electronics Conference which meets the same week.

Work also was started on the 1948 winter general meeting. Among the subjects in prospect for comprehensive coverage are hearing aids and picture and facsimile transmission.

SECTIONAL COMMITTEE C42

The first meeting of the executive committee of the reorganized ASA Sectional Committee *C42* was held Thursday afternoon, June 12, to discuss and agree on matters of general policy for guidance of the subcommittees in the revision and enlargement of the present "American Standard Definitions of Electrical Terms," *C42*–1941.

TELEMETERING

Results of the questionnaires sent to manufacturers of telemetering and supervisory control equipment were discussed at the meeting of the joint subcommittee on telemetering in Montreal, June 12, at which G. S. Lunge (A '23) chairman of the subcommittee, presided.

Detailed consideration was given by the meeting to the carrier channel portion of the revised text of the 1941 report on telemetering.

BASIC SCIENCES

A meeting of the committee on basic sciences of which J. D. Tebo (M '36) is chairman, was held June 13, 1947, to review the activities of the several subcommittees since the January 1947 meeting and to consider plans for the forthcoming general meeting in Chicago, Ill., November 3–7, 1947.

Doctor W. A. Lewis (F '45) chairman of the subcommittee on new energy sources plans a continuation of the survey of the several fields begun at the January 1947 meeting. Electrochemistry and thermoelectricity will be the principal subjects to be reviewed in a conference scheduled for the November meeting.

Professor J. G. Brainerd's (M '39) subcommittee on electric circuit theory now is working actively on a symposium to be held at the January 1948 general meeting in Pittsburgh, Pa. This symposium will cover recent developments.

C. Concordia's (M '37) subcommittee on large scale computing devices is planning publication of papers covering the material presented at the 1947 winter meeting and at the 1947 summer general meeting. Continued interest in this subject is indicated by the good attendance at both meetings. A summary of progress in the field has been suggested as an article to be published in *ELECTRICAL ENGINEERING*.

The committee considered the possible formation of a subcommittee on semiconductors. As the subcommittee on metallic rectifiers (Doctor L. O. Grondahl (M '42) chairman) of the committee on electrochemistry and electrometallurgy plans to include the subject of semiconductors in its activities, it was the opinion of the committee on basic sciences that the interests of the Institute membership were being served properly by Doctor Grondahl's subcommittee. The committee on basic sciences will co-operate with the subcommittee on metallic rectifiers to see that this activity is covered adequately.

As a number of the members of the committee on basic sciences are also members of subcommittee 1 of ASA Committee *C42*, Definitions of Electrical Terms, a review of the work of revising the definitions was made. In accordance with the subcommittee method of operation which has been a successful procedure for basic science activities, sections of the group terms (fundamental and derived, group 05) have been assigned to several individual members of the subcommittee, and progress has been reported. Further reviews are planned for a meeting in October 1947 and at subsequent AIEE general meetings.

INDUSTRIAL CONTROL DEVICES

Presentation of subcommittee reports was the main business before the meeting of the AIEE committee on industrial control devices held June 13, with J. D. Leitch (M '42) vice-chairman of the committee, presiding. Eight committee members were present.

The report of the subcommittee on electronic control was given by Mr. Leitch; that of the subcommittee on test code, by C. T. Evans (M '20); and on AIEE Standard 15, by E. H. Alexander (M '43).

Activities of the joint subcommittee on servomechanisms were outlined. The question of electrical hazards of steel mill controls was raised by H. H. Angel (M '45) and referred to the subcommittee on test codes and standards.

Papers on control of materials handling equipment and machine tools have been scheduled tentatively for the Midwest general meeting, and papers are being solicited for one or two sessions on steel mill control for the 1948 winter general meeting.

LIGHTNING AND INSULATORS

A meeting of the lightning and insulator subcommittee of the power transmission and distribution committee was held June 13, and I. W. Gross (F '45) chairman of the subcommittee, presided.

The committee decided to proceed with preparation of a bibliography of articles on lightning for the years 1936 to 1947 inclusive in lieu of the "AIEE Lightning Reference Book," which has been abandoned for the present because of high costs and lack of sufficient committments from prospective subscribers.

It also was announced that the subcommittee is working on projects which will culminate in papers on the following:

1. Preferred methods of predetermining the lightning performance of high voltage transmission lines.
2. Impulse characteristics of insulators—wood and air in series.
3. Operating experience with insulators in contaminated areas, and alleviatory methods used.
4. Lightning performance of medium voltage lines (33 to 66 kv inclusive).
5. Flashover characteristics of standard suspension insulators above 24 units (data now available).

AIEE 63d Annual Meeting Held in Montreal, Canada

Closing its 63d year of organizational life as a major instrumentality in the engineering world, and embarking upon its 64th year, the AIEE convened its official annual meeting in the City of Montreal, Province of Quebec, Canada as a part of the technical, business, and social program of the general summer meeting of the Institute. The session was called to order by President J. Elmer Housley at 10:15 o'clock on the morning of Wednesday, June 11, 1947, in Cardy Hall of the Mount Royal Hotel which served as general headquarters for the summer meeting.

In his introductory comments, President Housley stated that "For the fourth time since the founding of this great, international professional organization of ours in Philadelphia in 1884, we are gathered together in Canada for our summer general meeting, and this our annual business meeting. Upon the three previous occasions we have met in the Province of Ontario—the last time in 1941 in Toronto—and upon all these occasions have received the most generous treatment from our Canadian hosts. This is the first time that we have held such a meeting in the Province of Quebec, and I should like to take advantage of this opportunity to express appreciation, for myself and on behalf of the Institute, to our Montreal members and to their generous supporters for the exceptionally fine arrangements that have been made for the business, technical, and social affairs which constitute the splendid program for this summer meeting. . . . To extend our compliments and appreciation to General Chairman Beaubien and his effective committee staff, particularly his executive vice-chairman, Mr. Haberl.

"Next year we will take our summer meeting south of the border of the United States to Mexico City, and we are very happy to have representatives of our Mexico Section at this meeting. Our meeting in Mexico will afford further opportunity for the practical demonstration of the highly desirable qualities of international co-operation. . . ."

Report of Board of Directors

Secretary H. H. Henline, in presenting a brief résumé of the annual report of the board of directors, called attention to the fact that printed pamphlet copies of the report were available at the entrance to the meeting hall and that the report in full would be published (*EE, July '47, pp 714–36*) thus conveying to the entire membership a summarized report of the Institute's greatly expanded program of activities, as well as the annual financial report of the auditors.

Mr. Henline gave particular prominence to the facts that "The Institute has returned to a normal schedule of national and District meetings following the close of the war. These meetings are attracting larger attendances than ever before, and there are many other evidences of the very keen interest among our members. A new meeting has been established as the Midwest general meeting to be held this year in Chicago, Ill., November 3–7, so that now there are four national meetings per year . . . plus the District meetings. . . . There was a net gain of 1,388 members during the fiscal year which closed April 30, giving a total as of May 1 this year of 26,478; and the board, barring difficulties, will elect 900 new members tomorrow . . . the growth is continuing."

TREASURER'S REPORT

General regret was expressed at the fact that Treasurer W. I. Slichter (F '12) had been kept from the annual meeting by illness in his family. A formal resolution of regret was adopted unanimously for transmission to Treasurer Slichter through Secretary Henline. In presenting the treasurer's report on behalf of Mr. Slichter, Secretary Henline reminded his audience that, although the report covers the same income, disbursements, assets, and assessments of the Institute as does the detailed report of the auditors, the Treasurer watches all these items personally and presents his own report separate from the auditors' report in brief form as follows:

Annual Report of the Treasurer for the Fiscal Year, May 1, 1946, to May 1, 1947

	1946–47	1945–46
Receipts for the year	$593,590.22	$537,476.29
Out of pocket disbursements	537,135.76	395,978.86
Excess income for year	56,454.46	141,497.43
Transferred to surplus	154,766.60	125,084.27
Net cash gain or loss	98,312.14*	16,413.16
Assets		
Book value of all securities	$609,945.36	$483,662.69
Cash in restricted funds	23,488.62	47,304.66
Cash in working fund	6,883.37	81,379.47
Total assets	$640,317.35	$612,346.82
Investments		
Book value of all securities	$609,945.36	$483,662.69
Market value, May 1, 1947	629,189.88	552,893.92

* Loss or decrease.

NEW FELLOWS INTRODUCED

As a new feature in the program of the annual meeting, President Housley called upon Secretary Henline to read the names of the 81 AIEE members who became Fellows during the fiscal year May 1, 1946–April 30, 1947, as a mark of special recognition to those who have newly attained the Institute's highest professional membership grade. Several were present to rise and acknowledge their introductions as requested by President Housley. Although this listing was read in alphabetical order by Secretary Henline, the editors have rearranged the list and added information to indicate the distribution of these new Fellowships among the several Sections:

NEW AIEE FELLOWS,
MAY 1, 1946–APRIL 30, 1947

Boston Section

George Jackson Crowdes, assistant chief electrical engineer, Simplex Wire and Cable Company, Cambridge, Mass.

Edward W. Dillard, electrical engineer, New England Power Service Company, Boston, Mass.

Harold Eugene Edgerton, associate professor of electrical engineering, Massachusetts Institute of Technology, Cambridge, Mass.

George H. Jump, district engineer, New England district, General Electric Company, Boston, Mass.

Maurice Joseph Lowenberg, senior electrical engineer, Stone and Webster Engineering Corporation, Boston, Mass.

Herbert Rowland Stewart, protection engineer, New England Power Service Company, Boston, Mass.

Joseph Henry Yarnall, superintendent of power, Boston Elevated Railway Company, Boston, Mass.

Chicago Section

Theodore Bergen Holliday, partner, Mueller Accessories, Inc., Chicago, Ill.
William V. Kahler, general manager, State area, Illinois Bell Telephone Company, Chicago, Ill.
Alexander Joseph Krupy, senior engineer, system planning, Commonwealth Edision Company, Chicago, Ill.
Clarence E. Lomax, development engineer, Automatic Electric Company, Chicago, Ill.
Harry Paul Mahoney, chief consulting engineer, Automatic Electric Company, Chicago, Ill.
Harold James McCreary, electronics engineer, Automatic Electric Company, Chicago, Ill.
John Ellis Ostline, systems development engineer, Automatic Electric Company, Chicago, Ill.
Frank Erwin Sanford, Western editor, *Electrical World*, McGraw-Hill Publishing Company, Chicago, Ill.
James Hammond Starr, manufacturer, LaGrange, Ill.
Gifford Bethell West, chief engineer, State area, Illinois Bell Telephone Company, Chicago, Ill.

Cleveland

Dimiter Ramadanoff, research electrical engineer, Research Laboratory, National Carbon Company, Cleveland, Ohio.

Connecticut

Harry Farnsworth Brown, electric traction engineer, New York, New Haven and Hartford Railroad Company, New Haven, Conn.
Charles J. Daly, transmission and outside plant engineer, Southern New England Telephone Company, New Haven, Conn.
Charles Rufus Harte, engineer, The Connecticut Company, New Haven, Conn.
Philip H. Hatch, general mechanical superintendent, New York, New Haven and Hartford Railroad Company, New Haven, Conn.
Calvin T. Hughes, general superintendent, Connecticut Light and Power Company, Waterbury, Conn.
Herbert W. Sundius, equipment engineer, Southern New England Telephone Company, New Haven, Conn.

Denver

Nelson Roosevelt Love, chief engineer, Denver Tramway Corporation, Denver, Colo.

East Tennessee

Alfred Carter Crymble, special projects engineer, Tennessee Eastman Corporation, Kingsport, Tenn.

Ithaca

William W. Perry, chief engineer, New York State Electric and Gas Corporation, Binghamton, N. Y.

Lehigh Valley

Loyal Vivian Bewley, head of electrical engineering department, Lehigh University, Bethlehem, Pa.

Los Angeles

Eugene L. Bettannier, general manager and chief engineer, Municipal Light and Power Department, Pasadena, Calif.
Charles P. Garman, chief electrical engineer and deputy general manager, power system, Water and Power Department, City of Los Angeles, Los Angeles, Calif.
William S. Peterson, assistant chief electrical engineer, Water and Power Department, City of Los Angeles, Los Angeles, Calif.

Mexico

Basil Nikiforoff, chief electrical engineer, Mexican Light and Power Company, Mexico, Federal District, Mexico

Michigan

George M. Chute, application engineer, General Electric Company, Detroit, Mich.

Samuel M. Dean, chief engineer of the system, The Detroit Edison Company, Detroit, Mich.

Leroy Stewart Foltz, professor and head of electrical engineering department, Michigan State College, East Lansing, Mich.

James S. Gault, associate professor of electrical engineering, University of Michigan, Ann Arbor, Mich.

Walter G. Knickerbocker, superintendent of meters, The Detroit Edison Company, Detroit, Mich.

Joseph Chester Langdell, electrical engineer, Commonwealth and Southern Corporation, Jackson, Mich.

Milwaukee

Clarence T. Evans, consulting engineer, Cutler-Hammer, Inc., Wauwatosa, Wis.

Harold Winograd, engineer-in-charge, rectifier design, Allis-Chalmers Manufacturing Company, Milwaukee, Wis.

New York

Reginald Samuel Bennett, chief electrical engineer, T. Firth and J. Brown, Ltd., Sheffield, England.

Richard Morris Bush, electrical-mechanical engineer, special engineering division, Diablo Heights, Canal Zone.

Graham Claytor, operating vice-president, American Gas and Electric Service Corporation, New York, N. Y.

Robert Frank Hamilton, chief, public works and public utilities, U.S.A.C.A., Hq. U.S.F.E.A., c/o Postmaster, N. Y.

Horace Herndon Nance, engineer, long lines department, American Telephone and Telegraph Company, New York, N. Y.

Ralzemond Drake Parker, telegraph development director, Bell Telephone Laboratories, Inc., New York, N. Y.

Allen Danforth Pettee, chief engineer, General Cable Corporation, New York, N. Y.

A. Henry Pikler, consultant; partner, Pikler and Veros, engineers, Budapest, Hungary.

Earl G. Ports, technical director, radio division, Federal Telephone and Radio Corporation, Newark, N. J.

Walter LaVern Simpson, chief electrical engineer, Rio de Janeiro Tramway, Light and Power Company and São Paulo Tramway, Light and Power Company, São Paulo, Brazil.

Gordon Thompson, chief engineer, Electrical Testing Laboratories, Inc., New York, N. Y.

Philip Harold Trickey, chief engineer, Diehl Manufacturing Company, Finderne, N. J.

Harold Alden Wheeler, consulting radio physicist, Great Neck, N. Y.

North Carolina

Nathaniel E. Cannady, North Carolina State Electrical Engineer and Inspector, Insurance Department, Raleigh, N. C.

North Texas

John William Carpenter, president and general manager, Texas Power and Light Company, Dallas, Tex.

Philadelphia

John Grist Brainerd, professor of electrical engineering, Moore School of Electrical Engineering, University of Pennsylvania, Philadelphia, Pa.

Pittsburgh

Richard Thomas Stafford, manager, transformer section, Pittsburgh Works, Allis-Chalmers Manufacturing Company, Pittsburgh, Pa.

Ralph Haven Wright, steel mill engineer, Westinghouse Electric Corporation, East Pittsburgh, Pa.

Portland

Eugene Caldwell, general manager, Willamette Hyster Company, Portland, Oreg.

Orin Anton Demuth, chief, system engineering staff, Bonneville Power Administration, Portland, Oreg.

James H. Polhemus, president, Portland General Electric Company, Portland, Oreg.

Providence

Stanley Green, vice-president and chief engineer, Aerovox Corporation, New Bedford, Mass.

San Francisco

Lester Edwin Reukema, professor of electrical engineering, University of California, Berkeley, Calif.

Schenectady

Harold Whitney Bibber, chairman, engineering division, and professor of electrical engineering, Union College, Schenectady, N. Y.

Andrew Kidd Bushman, manager, application and service engineering divisions, apparatus department, General Electric Company, Schenectady, N. Y.

John Wendell Butler, sponsor engineer, central station engineering divisions, General Electric Company, Schenectady, N. Y.

Charles Concordia, analytical engineer, central station engineering divisions, General Electric Company, Schenectady, N. Y.

Martin Arthur Edwards, assistant engineer, general engineering and consulting laboratory, General Electric Company, Schenectady, N. Y.

Clifford McClain Foust, division engineer, high voltage and nucleonics division, general engineering and consulting laboratory, General Electric Company, Schenectady, N. Y.

Ernest Eldon Johnson, manager of engineering, apparatus department, General Electric Company, Schenectady, N. Y.

Charles Evans Kilbourne, designing engineer, motor and generator engineering division, General Electric Company, Schenectady, N. Y.

Thomas Merriam Linville, electrical engineer, motor and generator engineering division, General Electric Company, Schenectady, N. Y.

Chauncey Guy Suits, vice-president and director of electric research laboratory, General Electric Company, Schenectady, N. Y.

William Comings White, electronics engineer, research laboratory, General Electric Company, Schenectady, N. Y.

Seattle

Austin V. Eastman, professor of electrical engineering, University of Washington, Seattle, Wash.

Roy E. Kistler, transmission protection engineer, Pacific Telephone and Telegraph Company, Seattle, Wash.

Virginia

Joel Halbert Berry, district manager, electric department, Virginia Electric and Power Company, Norfolk, Va.

Claudius Lee, professor of electrical engineering, Virginia Polytechnic Institute, Blacksburg, Va.

James Shannon Miller, Jr., professor of electrical engineering, University of Virginia, University, Va.

Washington

Joseph Brown Feder, principal electrical engineer, United States Coast Guard, Washington, D. C.

Walter B. Bigelow, assistant chief, engineering division, Rural Electrification Administration, Washington, D. C.

1947–48 OFFICERS INDUCTED

The official report of the committee of tellers was read by Secretary Henline at President Housley's request in the absence of a representative of the committee which consisted of seven members of the New York Section: J. F. Moore, *chairman;* F. A. Blanding, E. A. Blomqvist; J. W. Danser; R. C. Darrow; F. A. DeArcangelis; and H. B. Margolis. The report disclosed that a total of 8,978 ballots had been received of which 26 were invalid because of receipt after June 1; 39 were invalid because of receipt from members in arrears for dues to April 30, 1947; and 150 invalid because of lack of member's signature; leaving a total of 8,763 valid ballots, on the basis of which President Housley declared the following list of new Institute officers duly elected for the administrative year which begins August 1:

1. President

Blake D. Hull, of the St. Louis Section.

2. Vice-Presidents

G. W. Bower, of the New York Section, for District 2—Middle Eastern.

J. H. Berry, of the Virginia Section, for District 4—Southern.

I. M. Ellestad, of the Nebraska Section, for District 6—North Central.

D. I. Cone, of the San Francisco Section, for District 8—Pacific.

D. G. Geiger, of the Toronto Section, for District 10—Canada.

3. Directors

W. L. Everitt, of the Urbana Section.

A. C. Monteith, of the Pittsburgh Section.

E. B. Robertson, of the Dallas Section.

4. Treasurer

W. I. Slichter, of the New York Section.

These new officers, together with the following holdover officers, will constitute the AIEE board of directors for the administrative year which begins August 1, 1947: J. Elmer Housley of Alcoa, Tenn. (retiring president); W. E. Wickenden of Cleveland, Ohio (junior past president); P. L. Alger of Schenectady, N. Y.; O. E. Buckley of New York, N. Y.; R. F. Danner of Oklahoma City, Okla.; G. W. Davis of Cambridge, Mass.; J. F. Fairman of New York, N. Y.; J. M. Flanigen of Atlanta, Ga.; R. T. Henry of Buffalo, N. Y.; T. G. LeClair of Chicago, Ill.; M. J. McHenry of Toronto, Ontario; J. R. North of Jackson, Mich.; D. A. Quarles of New York, N. Y.; W. C. Smith of San Francisco, Calif.; C. F. Terrell of Seattle, Wash.; E. P. Yerkes of Philadelphia, Pa.

At this point, President Housley called Mr. Hull to the platform, pinned upon his lapel the official gold AIEE emblem of his new office and formally introduced him as AIEE president for the administrative year 1947–48. Mr. Hull's remarks incidental to his acceptance, setting a pace and a pattern for next year's Institute administration, are given also in this issue (see page 799).

Institute Prizes Awarded

The recipients of the 1946 AIEE national prize awards for technical papers were announced at this point by M. D. Hooven (F '44) of the New York Section, chairman of the committee of award for Institute prizes, and also chairman of the AIEE technical program committee. Each such national prize award consists of an appropriately engrossed certificate and a check for $100, the cash award being divided where there are two or more coauthors. Mr. Hooven named the following recipients:

Best Paper in Engineering Practice. Prize awarded to H. A. P. Langstaff (F '43) West Penn Power Company, Pittsburgh, Pa.; H. R. Vaughan (M '41) Kansas City, Mo., and R. F. Lawrence (A '44) of East Pittsburgh, Pa., both with the Westinghouse Electric Corporation, for their paper, "Application and Performance of Electronic Exciters for Large A-C Generators." Honorable mention was awarded to A. G. Ganz (M '46) Bell Telephone Laboratories Inc., New York, N. Y., for his paper, "Applications of Thin Permalloy Tape in Wide Band Telephone and Pulse Transformers," and to H. S. Black (F '41), J. W. Beyer (M '36), T. J. Grieser, and F. A. Polkinghorn (M '39), of the Bell Telephone Laboratories, Inc., New York, N. Y., for their paper, "A Multichannel Microwave Radio Relay System."

Best Paper in Theory and Research. Prize awarded to J. A. Becker (F '43), C. B. Green, and L. L. Pearson, of the Bell Telephone Laboratories, Inc., Murray Hill, N. J., for their paper, "Properties and Uses of Thermistors—Thermally Sensitive Resistors." Honorable mention was awarded to C. G. Veinott (M '34) Westinghouse Electric Corporation, Lima, Ohio, for his paper, "Effect of Altitude on Ventilation and Rating of Aircraft Electric Machines."

Best Paper in Public Relations and Education. Prize awarded to V. P. Hessler (F '43), University of Kansas, Lawrence, Kans., for his paper, "Teaching Electricity and Magnetism."

Initial Paper. Prize awarded to J. J. Riley and C. E. Smith (M '44) The Taylor Winfield Corporation, Warren, Ohio, for their paper, "Influence of Magnetic Materials on the Electric Welding Characteristics of Resistance Welding Machines." Honorable mention was awarded to G. W. Heumann (M '46) and W. F. Strong (A '41) General Electric Company, Schenectady, N. Y., for their paper, "Electronic Control of Frequency Converter Sets for Testing Aircraft Models."

Branch Paper. Prize awarded to James W. Crooks, Jr. (A'47) Kansas State College, Manhattan, Kans., for his paper, "A Variable-Speed Constant Frequency A-C Generator."

However, none of the authors of the prize-winning papers was present to receive his award.

AIEE Lamme Medal Presented

"For his foresight, leadership, and creative contribution in the development of switching equipment," President Housley presented the AIEE 1946 Lamme Medal to John B. MacNeill (F '42) of the Pittsburgh Section, manager of the switchgear and control division, Westinghouse Electric Corporation. Preliminary to this ceremony, A. C. Monteith (F '45) of the Pittsburgh Section, member of the AIEE Lamme Medal committee, and director-elect, outlined some of the works and philosophies of Benjamin Garver Lamme which underlined the annual award, declaring that "the Medal not only serves... to recognize one outstanding engineer each year, but also it requires the electrical profession to sit down each year and count its blessings one by one. In this way, we are made more conscious of the achievement of one man, and recognition of him serves as a further inspiration to the rising generation in the profession. . . ."

The career of Medalist John B. MacNeill was the subject of a searching address by S. M. Dean (F '46) of the Detroit Section, chief engineer of the system for the Detroit Edison Company. Choosing for the topic of his response "The Switching of Large Power," Medalist MacNeill presented an interesting résumé of the development of heavy duty power system switching equipment, with special emphasis on the important part played by the pioneering spirit of several power companies in making system short-circuit tests under operating conditions. (Essentially the full text of this group of three Lamme Medal addresses is given elsewhere in this issue; see pages 747–53.)

President Housley Speaks

President Housley pointed out that in making an address at this annual meeting, he was meeting the requirements of Section 39 of Article VII of the AIEE constitution which enumerates the duty of the AIEE president, including the specific requirement "that he shall deliver an address at an annual convention." President Housley summed up the accomplishments and the present challenging opportunities of of the electrical engineering profession in particular and the engineering profession in general under the topic, "Engineering—Instrument of Peace." (For the text of this address see page 798.)

Prior to his address, President Housley gave high praise to the work of the AIEE headquarters staff and called for a "Special Commendation for the splendid job which they have done" to which the audience responded with hearty applause. Mr. Housley asserted that "as the Institute grows, our staff in effect gets smaller. Other societies have expanded their staffs several fold, but we have been going along without much change in the size of the staff. For a number of years the staff has carried a terrific burden, and a large amount of work resulting from the expansion of our activity and the broadening of the field of electrical engineering. . . . The tempo of today is terrific."

New Sections Voted by Board of Directors

Authorization of two new AIEE Sections was among the numerous items of business completed at the regular meeting of the board of directors, held June 12, during the AIEE summer general meeting in Montreal. The Sections approved were: the Shreveport Section (formerly a Subsection of the New Orleans Section) and the Panhandle Section (formerly a Subsection of the North Texas Section).

New appointments, changes in the bylaws, and committee reports also made up the agenda.

BYLAWS

Amendments to the bylaws were adopted, as follows, upon recommendation of the committee on constitution and bylaws:

Section 8 Deleted. Pertaining to preliminary consideration by board of examiners of applications for transfer to grade of Member.

Section 41. Reference to finance committee deleted (as that committee does not enter into discussion of Section territory. Financial support of Sections is covered by Section 48.)

Upon recommendation of a special committee to review the provisions for the purchase of life membership (Sec. 20, Constitution; Sec. 21, Bylaws) and exemption from future payment of dues as a Member for Life (Sec. 22, Constitution; Sec. 20, Bylaws), the board voted to instruct the committee on constitution and bylaws to take the necessary steps for the deletion of Section 20 of the constitution and Section 21 of the bylaws, in order to terminate the provisions for the purchase of life membership.

COMMITTEES

Mr. Ransom made a progress report of the situation with respect to a revision of the National Labor Relations Act.

A proposal for a special committee on professional relations, with a scope including methods of handling professional and economic problems of engineers and industrial relations, and providing information and assistance to electrical engineers in the formation of engineering associations for such purposes, was referred to the committee on planning and co-ordination for recommendation to the board.

Chairman F. A. Cowan (F '45) of the special committee to review the practices in the award of Institute prizes presented a report of that committee, which was discussed and referred to a conference of vice-presidents and District secretaries held the next day.

The annual report of the board of directors for the fiscal year which ended April 30, 1947, prepared by the secretary, was approved for publication in *ELECTRICAL ENGINEERING.*

OTHER SOCIETIES

The technical program committee, upon its request, was authorized to arrange a joint conference session, during the 1947 Midwest general meeting of the Institute, with the Second International Lighting Exposition and Conference.

An invitation to send one or two delegates to the centenary celebration of the Royal Netherlands Institution of Engineers during the week beginning September 22, 1947, was referred to the president with power to act.

The board accepted a proposal of the Italy America Society to turn over to AIEE all assets in the Alessandro Volta Memorial Fellowship Fund ($18,700.15) to be used for a purpose consistent with the objects for which the memorial originally was established.

APPOINTMENTS

The appointment of a Fellow of the Institute (not a member of the board of directors) as a member of the board of trustees of the Retirement System for AIEE Employees for the 4-year term beginning August 1, 1947, was referred to the president with power to act; also, the appointment of an AIEE representative on the Engineers' Council for Professional Development for the unexpired term, ending in October 1947, of E. C. Stone (F '31) resigned.

H. H. Henline (F '43) was reappointed secretary of the Institute for the administrative year beginning August 1, 1947, in accordance with Section 37 of the constitution.

STANDARDS

The board confirmed actions of the executive committee by letter ballot on recommendations of the Standards committee, as follows:

1. Authorization of appointment of J. H. Lampe (M '26) as representative of the Institute, and A. M. Unger (A '40) as alternate, on Sectional Committee *Z49.1*, Safety in Electric Welding and Gas Welding and Cutting Operations.

2. Adopted as AIEE Standards, revisions of:
(*a*) Report 40, "Electric Recording Instruments."
(*b*) Report 700, "Aircraft D-C Apparatus Voltage Ratings."

MEMBERSHIP

Recommendations adopted by the board of examiners at its meeting May 15, 1947, were reported and approved.

The following actions were taken upon recommendation of the board of examiners:

12 applicants were transferred, one was elected, and one was reinstated to the grade of Fellow; 71 applicants were transferred and 34 were elected to the grade of Member; 918 applicants were elected to the grade of Associate; 683 Student members were enrolled.

Report was made and approved of disbursements from general funds for the month of May amounting to $60,272.26.

As required by the Institute bylaws, the board directed the transfer from the active membership list to a "suspended" list of the names of all members in arrears for dues for the fiscal year which began May 1, 1946. The time for payment of these dues was extended until further action by the board.

Present at the meeting were:

President—J. Elmer Housley, Alcoa, Tenn. *Past President*—C. A. Powel, East Pittsburgh, Pa. *Vice-Presidents*—O. E. Buckley, New York, N. Y.; R. F. Danner, Oklahoma City, Okla.; E. W. Davis, Cambridge, Mass.; E. S. Fields, Cincinnati, Ohio; F. L. Lawton, Montreal, Que.; L. M. Robertson, Denver, Colo.; C. F. Terrell, Seattle, Wash.; H. B. Wolf, Charlotte, N. C. *Directors*—P. L. Alger, Schenectady, N. Y.; J. M. Flanigen, Atlanta, Ga.; R. T. Henry, Buffalo, N. Y.; C. M. Laffoon, East Pittsburgh, Pa.; M. J. McHenry, Toronto, Ont.; C. W. Mier, Dallas, Tex.; S. H. Mortensen, Milwaukee, Wis.; J. R. North, Jackson, Mich.; D. A. Quarles, New York, N. Y.; Walter C. Smith, San Francisco, Calif.; E. P. Yerkes, Philadelphia, Pa. *Secretary*—H. H. Henline, New York, N. Y. By invitation: *Incoming officers*—B. D. Hull, St. Louis, Mo.; J. H. Berry, Norfolk, Va.; G. W. Bower, Haddonfield, N. J.; I. M. Ellestad, Omaha, Nebr.; D. I. Cone, San Francisco, Calif.; D. G. Geiger, Toronto, Ont.; W. L. Everitt, Urbana, Ill.; A. C. Monteith, East Pittsburgh, Pa.; Elgin B. Robertson, Dallas, Tex. *Part Time*—F. A. Cowan, chairman, special committee to review the practices in the award of Institute Prizes; and C. W. Ransom, AIEE representative on Engineers' Joint Council panel on labor legislation.

Conference on Student Branches Held in Montreal

A conference on Student Branches was held in Montreal, June 10, 1947, during the summer general meeting under the sponsorship of the AIEE committee on Student Branches and with Chairman J. F. Calvert (F '45) of the committee presiding. The following notes covering this conference were prepared by Chairman Calvert.

The subcommittee on the establishment of new Student Branches [consisting of E. M. Strong (M '40), *chairman;* E. S. Lee (F '30); and R. G. Warner (F '45)] reported through its chairman. During the year, applications for the establishment of new Student Branches have been received from five schools. It was noted that one of them, Wayne University of Detroit, Mich., was recommended to the board for the establishment of a Student Branch. Wayne University has an Engineers' Council of Professional Development accredited course of study in electrical engineering.

No information was presented to show that there were circumstances relating to the other United States schools applying which would indicate that ECPD would have been unable to act, had it been asked to do so, and these schools could have been accredited by ECPD by this time. Consequently, it was the vote of the committee on Student Branches (including the Branch counselors present) that these schools be advised why the committee felt regretfully unable to recommend the establishment of Student Branches at this time. The essence of the decision was that, as an active supporter of ECPD, the AIEE could not go contrary to the sense and purpose of ECPD thinking unless there was cause to believe that ECPD had been unable to perform its full duties.

The thought was expressed that the schools not accredited could establish local electrical clubs for the students, if they had not already done so, and that assistance for these clubs might be secured in many ways through near-by AIEE Sections. The AIEE is usually able and nearly always glad to endeavor to supply suitable speakers for groups interested in electrical engineering. Also the AIEE welcomes guests to its own technical Sections meetings. The committee is hopeful that, following ECPD accrediting of the electrical engineering departments in each of these schools, the AIEE may receive applications for the establishment of a Student Branch at each, and prompt action on such cases can be assured. Also it is hoped that, if other assistance can be afforded through the AIEE, it will be asked for.

One school from outside the United States, and hence outside the areas of ECPD accrediting, applied during the year for the establishment of a Student Branch. The committee has been unable to secure really pertinent information beyond that given in the published material forwarded with the application from the institution, but the subcommittee expects to make strenous efforts to prepare a report for either the fall or winter general meetings.

A related matter was disposed of, namely, the general case of a university which has a branch of the school in another city. A specific case was treated, not as an isolated problem, but to establish a precedent and general pattern. The University of Illinois, Urbana, has inaugurated at Navy Pier, Chicago, Ill., courses of study including the first two years in electrical engineering. The university is responsible in every way for the Navy Pier School, it is in fact part of the University of Illinois. Its curriculums, teaching staff, facilities, and so forth, are determined by the university, which has an ECPD accredited curriculum and an AIEE Student Branch at Urbana. The department of electrical engineering desires to have an AIEE subbranch or division at Navy Pier. The committee on Student Branches not only agreed that this would be fully within the scope of the AIEE activities at the University of Illinois, but also urged that at this and at other universities in similar situations, such subbranches or divisions be established working out of the main Student Branch or principal electrical engineering department headquarters.

In a number of places throughout the United States, there are junior colleges where students complete their sophomore work before proceeding to the universities to take electrical engineering courses. In some cases rather close relations exist between the colleges and the university, but the university definitely is not responsible for the educational policies of the junior college. The question arose "Should subbranches be established at these junior colleges as the curriculums of the latter are not ECPD accredited in electrical engineering?" It was agreed (through discussion only) at the meeting of the committee on Student Branches, that local Sections and Student Branches might render local assistance and encourage the establishment of electrical clubs at the junior colleges, but with the clear understanding that this does not imply that such an electrical club eventually might become an AIEE Student Branch.

During the spring of 1947 a joint subcommittee was formed with the membership committee (at the latter's suggestion) to consider the establishment of a procedure for automatic transfer from Student grade to Associate grade in the Institute. The representatives from the committee on Student Branches were L. T. Rader (M '43) senior member; M. M. Cory (F '40); and A. G. Ennis (M '38). Only a preliminary report was asked for at this time in the discussion following the report. Rather strenuous objections were raised to the principle of automatic transfer, and chief among them are those indicated below:

1. There are in the AIEE corporate members of three grades (Fellows, Members, and Associates) and there are Student members. Admission to corporate membership does and, it was thought, should require application through and recommendation to the board by the examining committee.
2. There would be the question of increased dues without the written approval of the student if an automatic transfer scheme were to be worked out.
3. There might be a failure upon the part of the student to recognize the importance it is desired to have ascribed to corporate membership.
4. There would be the possible problems resulting from dues falling in arrears for certain men in case an automatic transfer procedure were adopted, and the legal aspects of automatic transfer from student to corporate membership are at this time unexplored.

The purpose behind the idea of automatic transfer was to prevent the loss of potential membership at a time when a student becomes an active engineer. He then is busy with his work and his address is changing in a manner difficult to follow. It was decided to suggest the continuation of the joint subcommittee with the purpose of studying all ways for facilitating the transferring from Student to Associate grade, thus not limiting the study to the automatic procedure as has been done for the past few months. The basic purpose is an admirable one, and it is hoped that a further report may be expected at the fall, or at the latest, the winter meeting.

Mr. R. G. Warner briefly reviewed the matter of student prizes. He commented on the fact that the summer meeting (1947) in Montreal marked the inauguration of a session at which District Branch prize papers were required to be presented from about half of the Districts. This year, the Members-For-Life Fund made it possible for the Branch prize papers from the odd-numbered Districts to be presented. Another year the winning papers from the even Districts may be cared for similarly. Mr. Warner also advised that there were certain other awards under consideration, about which he was not yet in a position to provide definite information.

Some of those present urged that, in regard to receiving publications, Student members should be granted the same privileges as corporate members, and they were informed that this matter is already under consideration by the publications committee.

Prior to the meeting, the chairman had received from two counselors letters which suggested somewhat divergent views on the procedure for the selection of District Branch prize papers. Because of the lateness of the hour, this was not introduced for discussion. Data on present procedures are available at AIEE headquarters.

Lack of time also prevented a discussion of joint Student Branches. The new bylaws and the last annual report of the committee on Student Branches should prove clarifying for those interested. In essence, with certain restrictions applied, a Joint Student Branch upon the approval of the board of trustees, may be established with Students of the AIEE and those of certain other societies as Student members; but at present a pending constitutional change must be completed before waiver of the AIEE entrance fee can be granted to Institute of Radio Engineers, American Society of Mechanical Engineers, or other types of members in the Joint Branch, as it now is granted to AIEE Student members at the time of their graduation from college.

The meeting was called to order at 9:40 and adjourned at 12 noon. Attendance was between 50 and 75, and the discussions were numerous and energetic throughout the meeting.

Engineering Profession Affected by Labor Management-Relations Act of 1947

A report submitted by C. W. Ransom (A'36) for AIEE President J. Elmer Housley states that "the new Labor Management Relations Act, combined with the expressed intent of the Congress as recorded in the legislative history of the bill (HR 3020), meets practically all of the objectives expressed in recent months by AIEE members.

"It retains collective bargaining rights for the minority who wish to remain under the coverage of the act. Full freedom of choice in exercising or rejecting collective bargaining is assured professional employees. This is accomplished by defining the term, 'professional employee,' and the addition of a mandatory provision requiring that the National Labor Relations Board (NLRB) group professional employees separately, for the purpose of conducting a collective bargaining election.

"Provision also is made whereby groups of employees constituting an appropriate unit (professional employees) may reject a previously selected bargaining representative, providing 12 months have elapsed since a valid election. As this involves the application of several sections of the act, the detailed procedure by which it is to be accomplished will have to be established by administrative rulings of the NLRB.

"The definition of the term 'supervisor' is decidedly more restrictive than the definition proposed in the bills prepared early this year. The extent to which it will exclude engineers previously covered by the National Labor Relations Act, if any, will depend on the interpretation placed on it by the NLRB and ultimately by the United States Supreme Court.

"The legislative record indicates that the new law also has achieved the freedom for nonunionized unstratified professional employees desired by the majority of the Institute members (84 per cent according to the membership opinion poll). In the "Statement of the Members on the Part of the House" in the House of Representatives Report 510 on HR 3020, the following appears:

> Section 8 (*d*) (3) of amended Labor Act in the House bill provided that nothing in the act was to be construed as prohibiting an employer from forming or maintaining a committee of employees and discussing with it matters of mutual interest, if the employees did not have a bargaining representative. This provision is omitted from the conference agreement since the act by its terms permits individual employees and groups of employees to meet with the employer and section 9 (*a*) of the conference agreement permits employers to answer their grievances.

"Thus, this expression of Congressional intent indicates that for all practical purposes, Congress has granted optional exemption.

"The sections of the bill of particular interest to professional employees are as follows:

"*Section 2* (*12*). The term 'professional employee' means—(*a*) any employee engaged in work (I) predominantly intellectual and varied in character as opposed to routine mental, manual, mechanical, or physical work; (II) involving the consistent exercise of discretion and judgment in its performance; (III) of such a character that the output produced or the result accomplished cannot be standardized in relation to a given period of time; (IV) requiring knowledge of an advanced type in a field of science or learning customarily acquired by a prolonged course of specialized intellectual instruction and study in an institution of higher learning or a hospital, as distinguished from a general academic education or from an apprenticeship or from training in the performance of routine mental, manual, or physical processes; or (*b*) any employee, who (I) has completed the courses of specialized intellectual instruction and study described in clause (IV) of paragraph (*a*), and (II) is performing related work under the supervision of a professional person to qualify himself to become a professional employee as defined in paragraph (*a*).

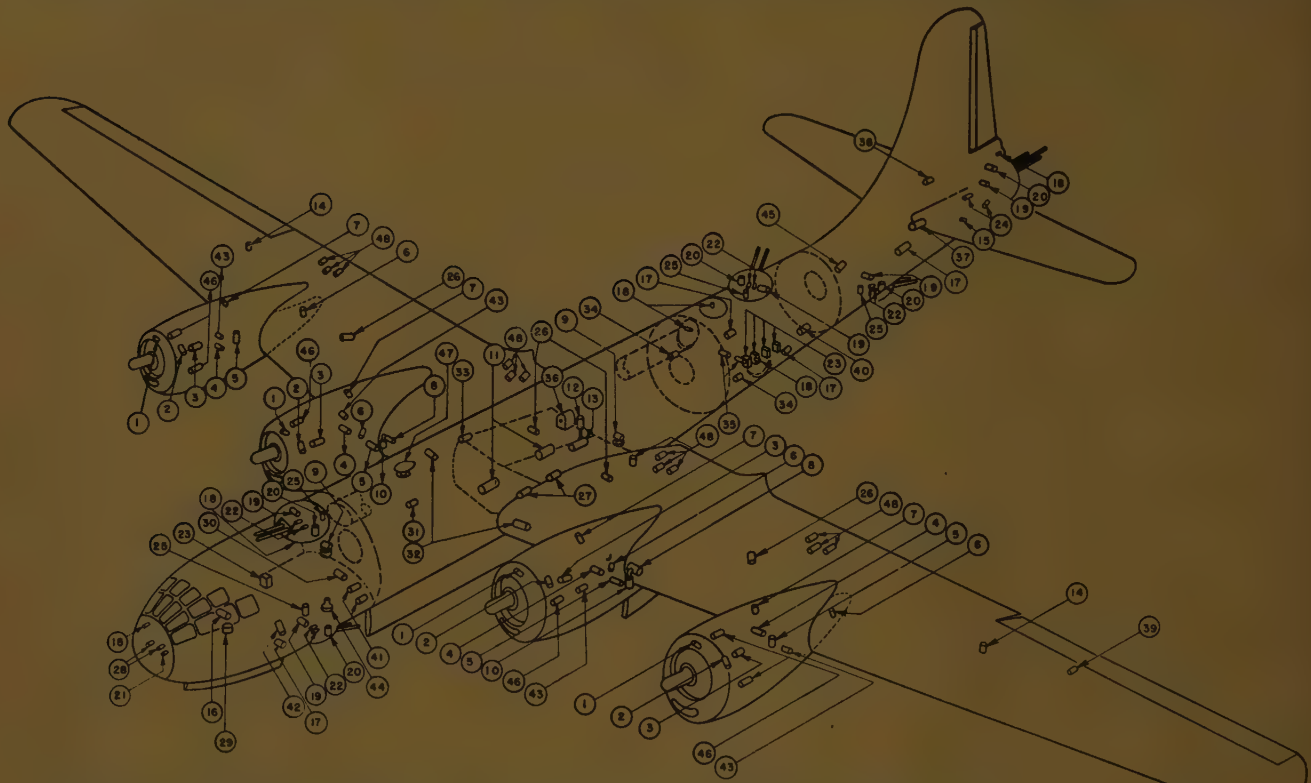
"*Section 9* (*b*). The Board shall decide in each case whether, in order to assure to employees the fullest freedom in exercising the rights guaranteed by this act, the unit appropriate for the purposes of collective bargaining shall be the employer unit, craft unit, plant unit, or subdivision thereof: Provided, that the Board shall not (1) decide that any unit is appropriate for such purposes if such unit includes both professional employees and employees who are not professional employees unless a majority of such professional employees vote for inclusion in such unit; . . .

"*Section 9* (*c*) (I). Whenever a petition shall have been signed in accordance with such regulations as may be prescribed by the Board—(*A*) by an employee or group of employees or any individual or labor organization acting in their behalf alleging that a substantial number of the employees—(II) assert that the individual or labor organization, which has been certified or is being currently recognized by their employer as the bargaining representative, is no longer a representative as defined in section 9 (*a*);—the Board shall investigate such petition and, if it has reasonable cause to believe that a question of representation affecting commerce exists, shall provide for an appropriate hearing upon due notice. Such hearing may be conducted by an officer or employee of the regional office, who shall not make any recommendations with respect thereto. If the Board finds upon the record of such hearing that such a question of representation exists, it shall direct an election by secret ballot and shall certify the results thereof.

"*Section 2* (*11*). The term 'supervisor' means any individual having authority, in the interest of the employer, to hire, transfer, suspend, lay off, recall, promote, discharge, assign, reward, or discipline other employees, or responsibility to direct them, or to adjust their grievances, or effectively to recommend such action, if in connection with the foregoing the exercise of such authority is not of a merely routine or clerical nature, but requires the use of independent judgment."

The AIEE, along with the other major engineering societies, has been active in studying and making recommendations regarding labor legislation for some time. These activities, along with those of the other societies, have been reported in the pages of *ELECTRICAL ENGINEERING*, including such items as the board of directors action on collective bargaining (*EE, Mar '47, p 297*), the Engineers Joint Council's adoption of the American Society of Civil Engineers labor policy (*EE, Mar '47, p 316*), distribution of the Wagner Act opinion poll to AIEE membership (*EE, May '47, p 495*), views of engineers on Wagner Act changes (*EE, May '47, p 510*), AIEE labor legislation poll and action (*EE, June '47, p 594*), collective bargaining pamphlets (*EE, June '47, p 597*), AIEE directors' approval of the committee on the National Labor Relations Act (*EE, June '47, p 597*), and the committee on collective bargaining section of the board of directors report (*EE, July '47, p 715*).

Middle Eastern District Meeting to Feature Aircraft Applications



Aircraft electrical applications in small motors will be featured at the Middle Eastern District meeting, September 23–25, 1947, Biltmore Hotel, Dayton, Ohio. Shown above is an excellent example of how electricity is used in an airplane, a diagram of a *B-29* Superfortress giving the 48 places where electric motors are used on this airplane. A total of 152 electric motors are used

STANDARDS • • •

Ninth Progress Report on AIEE Aeronautical Standards

The ninth progress report covering the aeronautical electrical standards activities, assigned to the committee on air transportation [chairman, J. D. Miner (M'42)], has been submitted to the AIEE Standards committee. The report, dated June 9, 1947, summarizes the activities of the various subcommittees since the eighth progress report (*EE, Feb '47, p 188*).

Aircraft Electrical Systems [*Subcommittee Chairman, W. F. Moore*]. The subcommittee has been reorganized under the chairmanship of W. F. Moore. It has released a preliminary draft, partially completed, of the "Aircraft Electrical Systems Guide Report." This draft has been preprinted and is being circulated by the Standards committee for criticism, comment, and for additional contributions.

The subcommittee is engaged actively in the preparation of a report on the magnitude of recovery voltages to be expected on 24-volt d-c aircraft electric systems. Work has been in progress on this project for a considerable length of time. Committee agreement could not be obtained on a previous report, and a new group of oscillograms currently is being analyzed to see if the results will be more consistent than those obtained previously.

Aircraft Electrical Rotating Machinery [*Subcommittee Chairman, M. L. Schmidt* (*M'43*)]. AIEE Standard 800, "Proposed Test Code for Direct-Current Aircraft Machines" was printed and issued for one year's trial use in March 1947. A working group now is engaged in developing rating standards for engine-driven generators.

Aircraft Electrical Control, Protective Devices, and Cable [*Subcommittee Chairman R. J. Lusk*]. A subcommittee report, "Time-Current Characteristics for Emergency Operation of Aircraft Cable," was completed and distributed in November 1946. It is planned to issue a test code for aircraft cable based on the work done in connection with this report. The subcommittee also is preparing a test code for circuit interrupting devices. A voltage regulator working group has been established recently, which is studying the problems associated with aircraft voltage regulators. It is too early as yet to state the form in which the work of this group eventually will be presented.

Basic Principles of Altitude Rating [*Subcommittee Chairman, W. E. Pakala* (*M'45*)]. This subcommittee was formed in 1946 to develop a report similar to AIEE 1, in that the report will be a basic standard for altitude rating of electric apparatus from sea level to 50,000 feet. The work of this subcommittee is still in its preliminary stages.

Joint Committee on Carbon Brushes [*Subcommittee Chairman, V. P. Hessler* (*F '43*)]. A preliminary test code is nearing completion. It will include methods of sampling and test procedure, brush materials, a description of brush testing equipment, and procedures for contact drop and friction test.

Aircraft D-C Apparatus Voltage Ratings (*AIEE 700*). This has been approved for publication as an AIEE Standard. Nominal voltages are 12 and 24 in agreement with American Standards Association Committee *C67*. Comments regarding details of the standard still are being received by the Standards Committee.

Aeronautical Definitions. ASA Committee *C42* has been set up under the chairmanship of C. L. Dawes (F '35) to review all electrical definitions. Subcommittee number 8 covers transportation, and a working group of this subcommittee, under the chairmanship of K. R. Smythe (M '44), is assigned the field of aeronautical electrical definitions. Several problems of nomenclature referred to AIEE have been passed on to the working group for recommendations.

Safety Conference. A conference on electrical safety in aircraft was held during the winter technical meeting in January. Minutes of the meeting were distributed and a limited number of extra copies are available at headquarters.

Introduction to AIEE Standards (AIEE Standard 1, June 1947). General principles upon which temperature limits are based in the rating of electric machines and apparatus are included in a Standard published for one year trial use by the American Institute of Electrical Engineers, 33 West 39th Street, New York 18, N. Y.

SECTION • • • • •

St. Louis Section Host to AIEE Presidents

On May 21, 1947, the St. Louis Section had the honor of playing host to the AIEE national president, J. E. Housley, and the AIEE president elect, B. D. Hull. Mr. Housley visited the St. Louis Section, of which Mr. Hull is a member, and spoke briefly at the executive committee's luncheon and the regular May meeting in the evening.

Some of those who attended the executive committee luncheon are shown here:

Members attending executive committee luncheon in St. Louis, Mo.

(Back row, left to right)

E. S. Rehagan (M '42) chairman elect, St. Louis Section
L. O. Campbell (M '29) chairman, educational committee
R. W. Schoetker (M '45) chairman, entertainment committee
R. N. Slinger (A '34) secretary-treasurer, elect
J. C. Lebens, Jr. (A '41) chairman, publicity committee
C. W. Schemm (A '27) chairman, membership committee
R. C. Horn (M '44) vice-chairman, national membership committee
L. H. Lovett (M '25) councilor of Student Branch, Missouri School of Mines and Metallurgy, Rolla
O. V. Tally (M '44) chairman, meetings and papers committee

(Front row, left to right)

J. W. Stephens, chairman of Student Branch, Missouri School of Mines and Metallurgy, Rolla
C. M. Wallis (M '41) councilor of Student Branch, University of Missouri, Columbia
H. B. Seybt (M '45) past chairman of Section
J. E. Housley (F '43) AIEE president
B. D. Hull (F '39) AIEE president elect
O. T. Farry (M '40) chairman of Section
G. Spradling, chairman of Student Branch, University of Missouri, Columbia

In addition to these men, the following attended the executive committee luncheon: R. W. Gaskins (M '37) secretary-treasurer; C. M. Lovell (F '44) past chairman; and H. M. Duphorne (A '29) chairman, fellowship committee.

Mr. Housley spoke briefly upon the problems confronting the national organization of the Institute, progress during his administration, and his hopes for the Institute next year.

Section and Branch Activities—Annual Report for 1946–47

The following constitutes the annual report on Institute Section and Branch activities for the fiscal year which ended April 30, 1947. Similar information for three preceding fiscal years appeared in *ELECTRICAL ENGINEERING* in July 1946, pages 352–4; June 1945, pages 228–9; June 1944, pages 224–5.

Present members of the Sections committee and the committee on Student Branches, supervising the divisions of Institute activities covered by this report on Section and Branch activities are:

Sections—G. W. Bower, *chairman;* R. M. Pfalzgraff, *vice-chairman;* A. C. Muir, *secretary;* D. I. Anzini, S. C. Commander, W. E. Enns, A. H. Frampton, H. P. Heafer, V. P. Hessler, W. R. Hough, R. E. Kistler, F. L. Lawton, C. W. Lethert, T. M. Linville, R. G. Porter, C. S. Purnell, H. B. Wolf, and, ex officio, chairmen of all Institute Sections.

Branches—J. F. Calvert, *chairman;* E. M. Strong, *vice-chairman;* L. T. Rader, *secretary;* M. M. Cory, H. L. Davis, Jr., Alfred G. Ennis, Everett S. Lee, Eugene W. O'Brien, Walter Charles Smith, R. G. Warner, Carl R. Wischmeyer, and, ex officio, all Student Branch counselors.

Table I. Section Membership and Meetings During Year Ending April 30, 1947

Section	AIEE Members August 1945	AIEE Members August 1946	Number of Meetings	Average Attendance
Akron	105	120	9	105
Electronics group			3	82
Industrial practice group			2	30
Power group			2	42
Canton Subsection			8	57
Alabama	37	101	10	76
Popular lecture			1	1,000
Arizona	60	73	11	56
Popular lecture			1	1,100
Distribution group			3	11
Meter and relay group			3	16
Power group			3	14
Beaumont	61	75	11	54
Boston	673	694	9	201
Distribution group			2	78
Electronics group			3	74
Industrial power application group			3	74
Instruments and measurements group			3	80
Insulation group			3	83
Land transportation group			1	47
Power generation group			2	91
Transmission group			2	91
Wire communications group			2	94
Central Indiana	147	187	8	71
Chicago	961	1,241	7	269
Communications group			4	115

Table I. Section Membership and Meetings During Year Ending April 30, 1947 (continued)

Section	AIEE Members August 1945	AIEE Members August 1946	Number of Meetings	Average Attendance
Electronics group			5	164
Industrial group			4	117
Power group			4	135
Cincinnati	161	191	9	97
Electronics group			2	30
Technical discussion group			5	44
Cleveland	424	511	15	150
Electric instruments group			4	19
Electronics group			4	22
Illumination group			4	6
Motors and control group			8	60
Columbus	90	94	9	76
Popular lectures			3	589
Zanesville Subsection			12	21
Connecticut	384	435	8	132
Dayton	243	258	11	110
Aeronautics group			3	28
Electric motors and control group			3	48
Industrial electronics group			3	44
Denver	209	284	11	123
Communications group			3	11
Electric equipment group			3	20
Electronics group			4	11
Industrial applications and processes group			3	8
Instruments and measurements group			4	15
Power systems group			3	37
Casper (Wyo.) Subsection			3	14
East Tennessee	288	284	19	65
Popular lecture			1	1,200
Technical group meetings			8	23
Erie	73	87	9	56
Florida	125	155		
Florida West Coast Subsection			2	37
Jacksonville Subsection			1	28
Miami Subsection			3	62
Fort Wayne	107	109	9	51
Georgia	145	179	9	60
Popular lecture			1	1,300
Communications and electronics group			1	75
Houston	143	187	16	110
Communications group			4	34
Industrial applications group			5	107
Illinois Valley	47	80	22	174
Communications group			3	26
Electronics group			1	40
Industrial maintenance group			4	25
Instruments and measurements group			1	37
Power group			1	37
Iowa	85	104	8	140
Rock Island Subsection			1	31
Ithaca	72	99	9	122
High voltage practice group			1	30
Kansas City	149	193	10	115
Electronics group			8	6
Industrial practice group			7	6
Lehigh Valley	188	215	9	99
Los Angeles	723	900	10	211
Aircraft division			6	109
Electronics division			7	123
Power division			8	177
Boulder Dam Subsection			6	59
Louisville	75	82	7	53
Popular lectures			2	549
Lynn	210	217	11	203
Popular lectures			3	1,183
Madison	81	90	8	50
Popular lecture			1	800
Rock River Valley Subsection			8	76
Mansfield	63	60	8	58
Maryland	417	448	11	178
Lancaster–York Subsection			7	123
Memphis	94	117	10	46
Little Rock Subsection			2	31
Mexico	181	195	5	83
Michigan	435	562	8	200
Electronics group			3	61
Industrial power group			1	130
Instruments and measurements group			3	87
Round table group			6	57
Saginaw Valley Subsection			[illegible]	116
Popular lecture			1	1,565
Milwaukee	409	500	10	235
Basic sciences group			3	52
Electric machinery group			4	30
Electronics group			4	51
Power applications and control group			4	49
Transmission and distribution group			4	39
Minnesota	133	184	9	66
Popular lecture			1	3,000
Arrowhead Subsection			1	70
Montana	71	72	6	82
Great Falls Subsection			7	21
Montreal	237	245	16	112
Ottawa Subsection			13	32
Muscle Shoals	19	23	2	17
Nebraska	48	60	9	62
New Mexico—West Texas	57	68	12	66
Albuquerque Subsection			0	
New Orleans	159	185	9	60
Popular lecture			1	540
Baton Rouge Subsection			1	
Lake Charles Subsection			9	27
Shreveport Subsection			10	44
New York	3,949	4,199	8	466
Basic science division			5	191
Communication division			6	197
Illumination division			4	151
Power and industrial division			14	82
Transportation division			6	65
Hudson Valley division			1	30
Mayaguez division			1	6
New Jersey division			4	96
Niagara Frontier	198	232	19	68
Niagara Falls Subsection (included in foregoing total)				
North Carolina	137	174	2	70
Charlotte Subsection			7	31
North Texas	199	272	11	93
Electronics group			7	63
Industrial practices group			2	24
Fort Worth Subsection			6	48
Panhandle Subsection			9	46
Oklahoma City	109	133	9	102
Basic science group			4	15
Communication group			4	16
Electronics group			5	20
Illumination group			2	10
Instruments and measurements group			4	11
Power systems group			4	20
Philadelphia	925	1,086	9	23
Basic science group			3	125
Communication group			5	154
Electronics group			3	44
Industrial practice group			3	33
Instruments and measurements group			3	68
Power systems group			3	103
Princeton–Trenton discussion group			1	52
Wilmington Subsection			8	111
Electrification of industrial plants group			1	40
Pittsburgh	693	772	14	131
Pittsfield	200	221	7	125
Popular lectures			6	1,033
Electronics group			6	28
Portland	228	302	13	112
Popular lecture			1	1,400
Communications			3	89
Education and student guidance			12	91
Electronics			4	84
Transmission and distribution			3	81
Providence	105	112	7	117
Popular lecture			1	1,000
Rochester	133	154	8	115
Communications group			1	111
Power group			1	55
St. Louis	347	377	11	118
Popular lecture			1	700
Electronics group			9	67
Illumination group			8	9
Industrial power practices group			5	21
San Diego	102	110	11	90
San Francisco	771	839	9	307
Communications group			4	115
Electronics group			4	62
Industrial practices group			8	43
Power systems group			4	60
Fresno Subsection			7	73
Red Bluff Subsection			4	45
Sacramento Subsection			7	79
Schenectady	654	701	4	218
Aviation group			2	105
Industrial electronics group			3	72
Industrial power applications group			5	46

Table I. Section Membership and Meetings During Year Ending April 30, 1947 (continued)

Section	AIEE Members August 1945	AIEE Members August 1946	Number of Meetings	Average Attendance
Power generation and transmission group			3	49
Technical discussion meetings			4	86
Seattle	304	310	8	189
Aircraft group			3	29
Electronics group			4	33
Power group			4	36
Sharon	149	144	9	128
South Bend	70	76	10	41
Technical discussion group			2	25
South Carolina	56	52	1	89
Charleston Subsection			0	
South Texas	56	83	8	46
Austin district technical discussion groups:				
Combined meeting			1	
Communication group			3	13
Electrolysis group			1	5
Industrial electronic group			4	5
Transmission and distribution group			1	9
Spokane	106	122	6	52
Springfield	60	66	8	51
Popular lecture			1	8,000
Instruments and measurements group			9	36
Syracuse	149	160	4	88
Toledo	67	89	9	83
Toronto	400	465	16	189
Communications technical group			4	59
Discussion group			10	50
Hamilton Subsection			9	103
Niagara Subsection			4	73
Tulsa	81	100	9	66
Technical meeting			1	5
Urbana	38	53	7	88
Popular lecture			1	600
Utah	77	94	11	52
Popular lectures			2	1,053
Vancouver	109	126	13	53
Electronics group			5	36
Virginia	138	151	4	133
Hampton Roads Subsection			7	36
Richmond Subsection			3	32
Washington	724	709	6	158
Popular lecture			1	1,000
Aeronautical applications group			2	25
Communications group			3	179
Electrical research group			3	40
Electronics group			2	88
Mathematics group			3	38
Power group			4	45
West Virginia	50	79	11	72
Electronics group			5	11
Wichita	86	82	13	42
Electronics group			1	21
Worcester	59	66	6	73
	19,918	22.675	1,370	

Total Sections, 75.

Total technical groups, 119.

Total Subsections, 35.

Additional Subsections established after the close of the fiscal year: San Jose (San Francisco Section), San Juan division (New York Section), Binghamton area (Ithaca Section), and Corpus Christi (South Texas Section).

Total attendance, 154,943.

Table II. Section Meetings Held During Last Three Fiscal Years

	Fiscal Year Ending April 30 1945	1946	1947
Number of Sections	73	75	75
Number of meetings held	884	1,187	1,370
Average number of meetings	12	16	18
Total attendance	96,346	116,294	154,943
Average attendance per meeting	109	98	113

Table III. Branch Meetings Held During Last Three Fiscal Years

	Fiscal Year Ending April 30 1945	1946	1947
Number of Branches	125	125	126
Number of meetings held	542	718	1,031
Average number of meetings	4	6	8
Total attendance	17,137	23,473	61,026
Average attendance per meeting	32	33	59

Table IV. Branch Meetings Held During Year Ending April 30, 1947

Branch	Number	Average Attendance
Akron, University of	8	32
Alabama, Polytechnic Institute	1	45
Alabama, University of	11	67
Alberta, University of	5	35
Arizona, University of	0	0
Arkansas, University of	14	29
British Columbia, University of	8	32
Brooklyn, Polytechnic Institute of		
Day division	5	32
Evening division	7	18
Brown University	6	25
Bucknell University	4	16
California Institute of Technology	6	75
California, University of	13	102
Carnegie Institute of Technology	42	0
Case School of Applied Science	14	65
Catholic University of America	0	0
Cincinnati, University of	8	60
Clarkson College of Technology	15	37
Clemson Agricultural College	12	33
Colorado State College	7	29
Colorado, University of	17	159
Columbia University	5	30
Connecticut, University of	4	67
Cooper Union		
Day division	3	25
Evening division	1	18
Cornell University	7	78
Delaware, University of	0	0
Denver, University of	10	51
Detroit, University of	6	93
Drexel Institute of Technology	8	43
Duke University	13	51
Florida, University of	3	33
George Washington University	6	48
Georgia School of Technology	2	21
Harvard University	0	0
Idaho, University of	11	36
Illinois Institute of Technology	11	84
Illinois, University of	9	284
Iowa State College	10	152
Iowa, University of	29	34
Johns Hopkins University	20	27
Kansas State College	9	304
Kansas, University of	7	51
Kentucky, University of	13	138
Lafayette College	8	23
Lehigh University	9	35
Louisiana State University	13	65
Louisville, University of	9	99
Maine, University	2	19
Manhattan College	1	15
Marquette University	11	27
Maryland, University of	5	22
Massachusetts Institute of Technology	14	73
Michigan College of Mining and Technology	12	30
Michigan State College	8	36
Michigan, University of	7	82
Milwaukee School of Engineering	1	26
Minnesota, University of	6	550
Mississippi State College	11	32
Missouri School of Mines and Metallurgy	4	64
Missouri, University of	7	45
Montana State College	12	46
Nebraska, University of	14	46
Nevada, University of	8	22
Newark College of Engineering	6	59
New Hampshire, University of	18	26
New Mexico State College	12	22
New Mexico, University of	7	23
New York, College of the City of		
Day division	23	95
Evening division	0	0
New York University		
Day division	4	40
Evening division	1	20
North Carolina State College	8	44
North Dakota Agricultural College	7	14
North Dakota, University of	5	18
Northeastern University	8	34
Northwestern University	11	152
Norwich University	0	0
Notre Dame, University of	15	34
Ohio Northern University	14	67
Ohio State University	0	0
Ohio University	0	0
Oklahoma Agricultural and Mechanical College	7	47
Oklahoma, University of	7	39
Oregon State College	13	59
Pennsylvania State College	2	35
Pennsylvania, University of	5	68
Pittsburgh, University of	15	101
Pratt Institute	4	62
Princeton University	0	0
Puerto Rico, University of	1	30
Purdue University	5	250
Rensselaer Polytechnic Institute	8	343
Rhode Island State College	4	23
Rice Institute	9	21
Rose Polytechnic Institute	6	38
Rutgers University	15	32
Santa Clara, University of	12	63
South Carolina, University of	3	22
South Dakota State College	9	37
South Dakota State College of Mines	1	419
Southern California, University of	16	26
Southern Methodist University	6	30
Stanford University	11	49
Stevens Institute of Technology	0	0
Swarthmore College	0	0
Syracuse University	4	32
Tennessee, University of	2	31
Texas Agricultural and Mechanical College	9	59
Texas Technological College	12	21
Texas, University of	10	47
Toronto, University of	0	0
Tufts College	2	39
Tulane University	4	21

Table IV. Branch Meetings Held During Year Ending April 30, 1947

(continued)

Branch	Number	Average Attendance
Union College	13	42
Utah, University of	9	43
Vanderbilt University	2	32
Vermont, University of	7	51
Villanova College	3	22
Virginia Military Institute	5	42
Virginia Polytechnic Institute	21	90
Virginia, University of	14	30
Washington, State College of	11	29
Washington, University of	4	75
Washington University	7	40
West Virginia University	11	43
Wisconsin, University of	12	65
Worcester Polytechnic Institute	5	35
Wyoming, University of	10	47
Yale University	4	30
Total, 126 Branches	1,031	

ABSTRACTS • • •

Air Transportation

47-176—Capacitance Fuel Gauges; *N. C. Clark, M. H. Adolphe (A '40). 25 cents.* A capacitance-type fuel gauge consists primarily of an electrical capacitor partially immersed in the fuel, a remote indicating capacitance meter, and the necessary associated equipment, and has potentialities for high accuracy. The minimum inherent error resulting from variations in fuel temperature from −65 to +110 degrees Fahrenheit is shown to be plus or minus one per cent, using temperature compensation and mid-range calibration, but no capacitance gauge equipment now available can be relied upon to this accuracy. Investigation shows that the use of an exceptionally accurate fuel gauge would not reduce the airplane fuel load or increase its pay load. Its inherent advantage is one of increased safety, particularly on long-range flight. Five models of capacitance-type gauges and one float gauge are described in this paper, along with an explanation of their basic circuits and operation, and a summary of laboratory test results.

47-179—Automatic Temperature Control for Transport Airplanes; *R. E. Hedges (A '44). 20 cents.* A description of the air conditioning system on the *DC-6* airplane, and the electrical circuits required for automatically maintaining the proper air temperature and pressure, are presented in this paper. The novel method of dividing the supercharged air into three portions, heating or cooling the separate portions as required, then remixing them to a single stream of properly conditioned air, and the functioning of the temperature sensitive bridge control circuits used to position the mixing valve are described.

47-197—D-C Aircraft Generator Power Center; *E. L. Bottemiller. 20 cents.* This paper covers briefly the design and construction of the General Electric aircraft generator power center which has been recently developed. This assembly combines the generator voltage regulator, generator control relay, reverse current breaker, and circuit protective breakers all in one draw-out unit, a feature which is a radical departure from the conventional method of mounting these various devices. The complete draw-out unit can be replaced by merely lifting a finger latch and withdrawing the unit, thus breaking all power and control circuits. The elementary power and control diagram is included to illustrate the manner in which the various devices function with respect to each other. The characteristics of some of the component devices are discussed from the over-all operational standpoint. Such advantages as ease of installation, interchangeability of units, ease of providing parallel operation of generators, and simplicity of design, are discussed.

47-202—Ground Power Supply for Modern Aircraft; *T. B. Owen (A '43), J. A. Murray (A '45), Allan Rosenstein (A '41). 30 cents.* Recently announced models of the latest in commercial air transports have incorporated in their design amazingly complex and large electrical systems. The increased demand in the airplanes' electrical system is the result of extensive use of the latest in navigational aids, flight operation components, the maximum of safety devices, and especially the tendency toward considerable passenger comfort aids. In flight, the engine-driven generators of the system have sufficient capacity to supply energy to the electrical system, but on the ground with the engines off, an adequate external ground power supply is needed. The problems imposed on ground power supply by voltage regulation limitations, stablity, ripple component of the d-c output, and overload demands are discussed. The basic types of ground power supplies are reviewed and the limitations, operation, and maintenance of each compared. Results of field operations of two basic types are illustrated. The design and engineering development of a large capacity electronically-controlled dry-disk rectifier for aircraft ground power is described in detail.

47-205—Electric Equipment Required in a Modern 6-Component Wind-Tunnel Model Suspension System; *H. Orville Cox (A '35). 30 cents.* The variable-density wind tunnels recently completed at Cornell aeronautical laboratory and the Southern California co-operative wind tunnel are probably two of the most versatile aerodynamic testing facilities in operation at present. A good share of this versatility results from the unusual model handling and force measuring equipment installed. Every effort was made to handle all types of models, move them in and out of the tunnel quickly, and support them properly throughout the entire range of tunnel air speeds and air densities. There resulted a much more complex system of mechanical equipment than is to be found in balance systems of earlier tunnels. This paper traces the development of the balance system, from an earlier basic system to the modern suspension system that exists in these tunnels. The primary functions of parts of the system are explained and the way in which the electric equipment was built into the compact mechanical assemblage is described. A complete description of the electric drives required, the control system used for automatic following of the windshielding and image system, and the power supply to the drives, is given. Some of the unique problems of installation and instrumentation that had to be handled as the work progressed also are discussed. It is pointed out that not all of the electrical problems in a modern wind tunnel evolve about the tunnel main drive unit or some power supply for the models but that there are many more applications of electric equipment and control. One of the most important of such applications is the model suspension system, if the modern wind tunnel is to be an efficient and easily operable facility.

Communication

47-182—Submarine Detection by Sonar; *A. C. Keller. 40 cents.* The *QJA* sonar system was used in World War II for supersonic underwater sound echo ranging, listing, and telegraph communication. It is a unicontrol system covering a frequency range of 10 to 30 kc. The transducer (transmitter-receiver) of the system is an array of 45-degree *Z*-cut *ADP* (ammonium dihydrogen phosphate) piezoelectric crystals. Other features of the system are *BDI* (bearing deviation indicator), *TVG* (time variation of gain), *MTB* (maintenance of true bearing), audio bandwidth control, a low noise level rotary contactor, and a new sound-transparent stainless-steel dome.

47-195—A Bearing Deviation Indicator for Sonar; *O. H. Schuck (M '41), C. K. Stedman, J. L. Hathaway, A. N. Butz, Jr. 35 cents.* This paper describes the bearing deviation indicator (*BDI*), a war development that greatly increased the effectiveness of sonar equipment in antisubmarine warfare. Limitations of sonar equipment without *BDI* are explained, the value of crossed-lobe techniques for improved bearing accuracy is discussed, and the value of simultaneous lobe comparison in underwater sound work is pointed out. Methods of meeting the over-all requirements are described, and examples are given of service equipment. Certain auxiliary features of these equipments—time-varied gain, reverberation-controlled gain, and own-doppler nullification are discussed, and mention is made of specialized test equipment.

Instruments and Measurements

47-198—Design and Application of Supersonic Flaw Detectors; *Donald C. Erdman. 25 cents.* General parameters are given for the circuits that make up echo-type supersonic flaw detectors used in the location of defects in large metal forgings. Applications of such equipment are listed and a bibliography of pertinent articles is included.

47-201—An Electro-Optical Shutter for Photographic Purposes; *A. M. Zarem (A '43), F. R. Marshall, F. L. Poole (M '39). 30 cents.* The increased tempo of scientific activity during the last few years has resulted in a demand for optical investigations of very rapidly changing phenomena. Mechanical means have been employed to yield photographic exposure times down to about 50 microseconds, and special flash lamp and other techniques have resulted in photographic records with effective exposure times in the microsecond range. The electro-optical shutter, the subject of this paper, provides a very versatile and practical means for obtaining exposure times over a very wide range. Because it contains no mechanical moving parts, it offers the possibility of attaining exposure times several orders of magnitude less than are obtainable by other means. As an example, an electro-optical or Kerr cell shutter with an effective exposure time of 0.000,000,04 second has been used routinely for photographic investigations of the electrical vaporization of fine wires. The phenomenon of electrical birefringence (the electrostatic Kerr effect) is not generally familiar to electrical engineers and consequently is discussed in some detail.

Mining, Metal Forming, and Rolling

47-181—A New Grinding Circuit Feed Regulator; *J. N. Jones (A '45). 20 cents.* The mining and milling industry is an attractive field for the application of regulators, and a new regulator for controlling the raw ore feed to ball mills has been introduced and proved. It is an electrical system whereby the amount of ore fed to ball mills is governed by the circulating load returning from the classifier. The regulator is simple, reliable, and inexpensive; automatically will change the rate of ore fed to the grinding circuit as the grindability or coarseness of the ore changes; and also proportionately varies the amount of water added to the ball mill as the raw ore feed is varied. This regulator has increased the efficiency of the mill both as to tonnage and metallurgy.

Power Generation

47-184—The Design and Performance of the Vertical Generator Thrust Bearings at the Bonneville Plant of the Corps of Engineers, War Department; *F. M. Lewis (M '44), T. W. Gordon. 25 cents.* Ten of the world's largest thrust bearings, each supporting a load of approximately 3,000,000 pounds, were installed in the machines at Bonneville during the period 1938–43. Each has been in practically continuous service since its initial date of operation. The operating record of this installation is of interest to the field of power generation as such a record shows what has been done with these large bearings and indicates their future possibilities. The bearings at Bonneville have passed through an initial stage of development, during which difficulties were encountered on the earliest installations and corrected by design changes; and are now in a second stage of continuous operation. Records of more than 40,000 running hours between inspections have been established and the bearings immediately returned to service after such inspections. All ten machines have been in this second stage nearly six years. It is expected that they will continue to deliver successful operation in the future.

47-199—Excitation Problems in Hydroelectric Generators Supplying Long Transmission Lines; *C. L. Killgore (A '37). 20 cents.* The characteristics of excitation systems which are now available and their application to hydroelectric generators supplying long transmission lines, as well as the problems of improving system voltage by introduction of droop in the voltage regulator circuit transmission of reactive power, power-factor rating of main generator, voltage levels on transmission systems, line charging current, overvoltages resulting from dropping load both at station and line end, effect of excitation system on stability, and use of minimum excitation limit to prevent pull out are described and discussed. Desirable characteristics which should be provided for excitation systems supplying long transmission lines are outlined.

Power Transmission and Distribution

47-180—Tests and Developments in Connection With Hot Line Insulator Washing; *G. Leslie Hill (M '43). 40 cents.* This paper shows the feasibility of cleaning insulators with a high pressure water stream and brings out information that will be helpful for operating men washing energized insulators. It covers the leakage current that may be expected to pass through the water stream for various pressures, nozzle sizes, distances, and resistivities of water. A study of various hydraulic nozzles was made, and tests were conducted on various nozzles obtained from manufacturers of fire fighting and tree spraying apparatus, and also upon various types of experimental nozzles. Experiments were made to determine the minimum specific resistivity of water that could be used for washing energized insulators without causing flashover. It is shown that energized insulators may be washed with a high pressure water stream far more safely and economically than when a line is de-energized and wiped by hand.

44-175—Broken Conductor Effect on Sags in Suspension Spans; *Alfio Bissiri, Maurice Landau. 35 cents.* A method is explained of calculating and plotting tension-length curves for suspended conductors. Application of the tension-length curves to the determination of increased sags in suspension spans occurring when a conductor breaks, and other transmission-line problems are described and illustrated. Other than for calculation of the tension-length curves, adequate accuracy is obtained using a 10-inch slide rule.

47-192—Conductor Vibration on Energized 230-Kv Transmission Lines; *M. G. Poland (A '46), M. B. Elton. (CP.)* The purpose of this paper is to describe briefly recording instruments used by the Bonneville Power Administration in the field measurement of conductor vibration, field installation on energized lines, field chart analysis, remedial or palliative measures necessary to reduce vibration on transmission-line conductors, and recent experience with fatigue damage. Inasmuch as considerable research has been done, both in the laboratory and the field, by many investigators, theoretical discussion of vibration phenomenon will not be attempted in this paper. Instead, this paper intends to deal with the practical aspects of conductor vibration as based on present knowledge. It is hoped that it also may be of value to those not intimately acquainted with the details of the subject, but who may be interested in the broader aspects.

47-203—A Simple and Inexpensive Method for Accurately Measuring Steady-State and Transient Voltages on High-Voltages; *Harold L. Levinton (M '45). 25 cents.* This paper presents a simple method for accurately measuring voltages present on high-voltage systems during both transient and steady-state conditions without modifying the conditions producing the voltage to be measured. An electronic "amplifier" having high input resistance and negligible circuit loading provides adequate current to operate magnetic oscillograph galvanometers (or meters, relays, and so forth) in proportion to the input voltage obtained from capacitance voltage dividers. These may be transmission-line switching-transient voltages, across circuit breaker contacts, static capacitor transient voltages, neutral displacement voltages, and so forth. Frequencies ranging from direct current to 100 or more kilocycles are within the capability of the device, although the actual value determined by the indicating or recording instrument which it actuates may be limited to a few thousand cycles. Limitations and problems encountered in the use of capacitance potential dividers also are discussed briefly.

Protective Devices

47-185—Circuit Breaker Current Measurements During Reignitions and Recovery; *Laurel J. Lewis (A '36). 25 cents.* This paper describes the technique employed to obtain high-speed oscillographic records of current near the current-zero periods, in interruption tests of a-c power circuits. The test results show the progressive changes which occur on successive half-cycles, and a correlation is noted between the magnitude of the current during the final recovery period and the form of the recovery voltage. Illustrations are given of the effect of shunting capacitance on the breaker characteristics. The importance of the energy relations in the reignition process is emphasized.

Servomechanisms

47-186—General Analysis of Speed Regulators Under Impact Loads; *G. D. McCann (M '44), W. O. Osbon (M '41), H. S. Kirschbaum (A '43). 40 cents.* This paper presents a comprehensive investigation with the mechanical transients analyzer of speed regulator systems with particular attention to speed drop due to impact loads. The data are applicable to systems with two electrical time delays, regulation by either motor field or armature voltage control, and with stabilization provided bv both *RC*-feedback and anticipation. The data present optimum performance characteristics in terms of transient speed drop and time of recovery for a wide range of system parameters. Stabilizing circuit constants corresponding to the optimum condition also are given. All data are given in dimensionless form suitable for general application.

PERSONAL ● ● ● ●

H. S. Black (A '43, F '41) member of the technical staff, system development department, Bell Telephone Laboratories, Inc., New York, N. Y., **J. W. Beyer** (A '17, M '36) member of the technical staff, Bell Telephone Laboratories; and **F. A. Polkinghorn** (M '39) member of the research department, Bell Telephone Laboratories; have received honorable mention in the field of engineering practice in the AIEE national prize paper award for 1946 for their paper, "A Multichannel Microwave Radio Relay System." Mr. Black, who holds the degrees of bachelor of science and electrical engineer from Worcester Polytechnic Institute, has been with Bell Laboratories since 1925. Previously he had been associated for several years with the Western Electric Company. He is a member of Tau Beta Pi and Sigma Xi and is the author of a number of technical papers. Mr. Beyer, a graduate of the State College of Washington, also was transferred from the staff of the Western Electric Company when Bell Telephone Laboratories was formed in 1925. He had been an instructor at the State College of Washington, Pullman, from 1916 to 1919. Mr. Polkinghorn was graduated with honors from the University of California in 1922. He entered the employ of Bell Laboratories in 1927 by way of the Pacific Telephone and Telegraph Company, San Francisco, Calif., for which he was an engineer from 1925 to 1927. He is the author of many technical papers and a member of Phi Beta Kappa, Tau Beta Pi, Eta Kappa Nu, and Sigma Xi.

H. A. P. Langstaff

H. R. Vaughan

R. F. Lawrence

A. G. Ganz (A '35, M '46) member of the technical staff, Bell Telephone Laboratories, Inc., has received honorable mention in the AIEE 1946 national prize paper award in the field of engineering practice for his paper, "Application of Thin Permalloy Tape in Wide Band Telephone and Pulse Transformers." Mr. Ganz was graduated from Stevens Institute of Technology in 1924 and received the degree of master of arts from Columbia University in 1930. He has been with Bell Telephone Laboratories since 1924, and from 1929 to 1941 was in charge of the development and design of carrier and radio-frequency transformers. Between 1941 and 1945 he supervised the design of video, sweep, and pulse transformers of radar circuits and supersonic transformers for underwater sound systems.

H. A. P. Langstaff (A '17, F '43) electrical engineer, West Penn Power Company, Pittsburgh, Pa.; **H. R. Vaughan** (A '31, M '41) Westinghouse Electric Corporation, Kansas City, Mo.; and **R. F. Lawrence** (A '44) Westinghouse Electric Corporation, East Pittsburgh, Pa.; have been awarded the 1946 AIEE best paper prize in the field of engineering practice for their paper, "Application and Performance of Electronic Exciters for Large A-C Generators." Born in Canada in 1886, Mr. Langstaff was graduated from Armour Institute of Technology in 1912. For a number of years he was associated with various consulting engineering firms on the construction and installation of electric railways and substations. In 1920 he joined the West Penn Power Company as relay engineer and, since 1927, has been titled electrical engineer. Mr. Vaughan is a graduate of the University of Colorado (1928) and has done graduate work at the University of Pittsburgh. After completing the student course he was appointed design engineer by the Westinghouse Company. In 1931 he was named central station engineer and in 1933 district engineer. He served as secretary of AIEE District 2 in 1943 and 1944. Mr. Lawrence was graduated from Pratt Institute in 1944 and entered the student course of the Westinghouse Company. He has been central station engineer since 1943.

C. G. Veinott (A '28, M '34) special development engineer, Westinghouse Electric Corporation, Lima, Ohio, has received honorable mention in the field of theory and research in the AIEE national prize awards for 1946 for his paper, "Effect of Altitude on Ventilation and Rating of Aircraft Electric Machines." Mr. Veinott holds the degrees of bachelor of science (1926) and electrical engineer (1938) from the University of Vermont. He has been with the Westinghouse Electric Corporation since 1926 as student engineer, assistant to the chief engineer, and since 1929 with the small motors engineering department in various capacities. He was awarded honorable mention in the 1936 Eta Kappa Nu selection of the outstanding young electrical engineer. Mr. Veinott also received honorable mention in the 1944 AIEE national prize paper awards. He is a member of Phi Beta Kappa.

J. A. Becker (F '43) research physicist, Bell Telephone Laboratories, Inc., New York, N. Y., has received the 1946 AIEE national best paper prize award in the field of theory and research, as co-author of the paper, "Properties and Uses of Ther-

V. P. Hessler

E. F. Cahoon

J. W. Crooks

H. M. Bascom

mistors—Thermally Sensitive Resistors." Born in Germany, Mr. Becker was graduated from Cornell University in 1918 and received the degree of doctor of philosophy in 1922. He was a research fellow at the California Institute of Technology from 1922 to 1924, and in 1924 joined the staff of the Laboratories. He is a former editor of the *Review of Scientific Instruments* and a fellow of the American Physical Society.

G. W. Heumann (A '44, M '46) industrial control engineer, and **W. F. Strong** (A '41) of the industrial control engineering department, General Electric Company, Schenectady, N. Y., have received honorable mention in the 1946 AIEE award for initial paper for their paper, "Electronic Control of Frequency Converter Sets for Testing Aircraft Models." Born in Germany, Mr. Heumann was graduated from the Dresden Institute of Technology in 1923. He was associated with the Siemens-Schuckert Works in Berlin until 1926 at which time he joined the Westinghouse Electric Corporation in East Pittsburgh, Pa. A year later he was appointed representative for the Allegemeine Electricitats Gesellschaft in Schenectady, N. Y., and in 1931 joined the General Electric Company, Schenectady, N. Y., as product engineer. Mr. Strong, a 1940 graduate of the University of Oklahoma, joined the General Electric Company as student engineer. After completing the student course he was assigned to the industrial products engineer department.

J. W. Crooks (A '47) engineer with the radio and electrical laboratories, Consolidated-Vultee Aircraft Corporation, San Diego, Calif., has received the 1946 AIEE national prize for Branch paper for his paper, "A Variable-Speed Constant-Frequency A-C Generator." Mr. Crooks was graduated with honors with the degree of bachelor of science in electrical engineering from Kansas State College in 1946. While a junior in college, he received the Consolidated-Vultee Scholarship Award, and after graduation joined the company's research laboratory as an analyst. He is a member of Eta Kappa Nu and Sigma Tau.

V. P. Hessler (A '20, F '43) professor and head of the electrical engineering department, University of Kansas, Lawrence, has been awarded the 1946 AIEE best paper prize in the field of public relations and education for his paper, "Teaching Electricity and Magnetism." He joined the faculty of Iowa State College, Ames, in 1927 as instructor and was named assistant professor in 1936. Professor Hessler is the author of a number of technical articles and is a member of the American Society for Engineering Education, Tau Beta Pi, Eta Kappa Nu, and Sigma Xi.

Humphreys Milliken (A '24, F '39) chief engineer and general superintendent Quebec Hydro-Electric Commission, Montreal, Canada, has retired. Mr. Milliken was born in Tennessee and was graduated from the Massachusetts Institute of Technology. He completed the student course at the General Electric Company, Schenectady, N. Y., in 1904 and was instructor for one year at the Case School of Applied Science, Cleveland, Ohio. Early in his career, he also was associated with the New York Edison Company, the Oregon Electric Railway, and the Delaware County Electric Company, Philadelphia, Pa. In 1911 he became chief electrical engineer for W. S. Barstow and Company, New York, N. Y. He joined By Products Inc., in 1919 as chief engineer and was with the Hugh L. Cooper Company, Muscle Shoals, Tenn., from 1922 to 1925. He was named chief engineer of the Montreal Light, Heat and Power Company in 1925 and chief engineer and general superintendent in 1934. When that company was taken over by the Quebec Hydro-Electric Commission in 1946, he continued in the same position with the Commission.

H. M. Bascom (M '19, F '30) director of switching engineering, Bell Telephone Laboratories, Inc., New York, N. Y., has joined the Stromberg-Carlson Company, Rochester, N. Y., as senior consulting engineer. Mr. Bascom's early communication experience was gained with the Acme Telephone Company and the Ericsson Telephone Company, both in New York. His association with the Bell System commenced in 1906 when he entered the engineering department of the New York and New Jersey Telephone Company. He was transferred to the engineering department of the American Telephone and Telegraph Company, New York, in 1909 and, when the department of development and research was formed in 1919, was made local central office development engineer. He continued in this position when the department merged with Bell Laboratories in 1934. He was appointed director of switching engineering in 1940. Mr. Bascom is credited with more than 80 patents in the communications field.

C. A. Atherton (M '42) has resigned his position with the Reynolds Metals Company, New York, N. Y. From 1925 to the outbreak of World War II, Mr. Atherton was technical director of Phoebus S. A., Geneva, Switzerland, an international organization of electric lamp manufacturers which he helped to organize. He previously had been associated with the General Electric Company, Schenectady, N. Y., and is the author of "Electric Sign Lighting." At present he is chairman of the handbook committee of the Illuminating Engineering Society and is an official representative on the United States National Committee of the International Commission on Illumination.

E. F. Cahoon (A '34) has rejoined TelAutograph Corporation, New York, N. Y., as chief engineer. Since 1942 Mr. Cahoon has been associated with W. L. Maxson and Company, New York, as development engineer working on confidential projects for the United States Navy. Mr. Cahoon is a graduate of Massachusetts Institute of Technology.

D. W. Ver Planck (A '31, M '41) formerly professor of electrical engineering, Carnegie Institute of Technology, Pittsburgh, Pa., has been appointed head of the department of mechanical engineering at the institute. Professor Ver Planck holds the degrees of bachelor and master of science from Massachusetts Institute of Technology and the degree of doctor of engineering from Yale

University. He was associated with the General Electric Company, Schenectady, N. Y., from 1929 to 1936 and in the latter years became an assistant professor in electrical engineering at Yale University, New Haven, Conn. He is a member of Tau Beta Pi and Sigma Xi and of the American Society for Engineering Education and an Associate Member of the United States Naval Institute.

C. F. Goodheart (A '39) formerly section chief at the Naval Ordnance Laboratory, White Oaks, Md., and **C. H. Buchanan** (A '37) formerly professor and head of the department of electrical engineering at the University of North Dakota, Grand Fork, have been appointed associate professors of electrical engineering at Union College, Schenectady, N. Y. Professor Goodheart received the degree of bachelor of science from California Institute of Technology in 1936 and the master of science degree from Ohio State University in 1938. He was on the faculty at Ohio State University, Columbus, until 1938 and at Texas Agricultural and Mechanical College, College Station, from 1938 to 1942. He joined the Naval Laboratory in 1942. Professor Buchanan was graduated from the University of Vermont in 1936 and received his masters degree from the University of Pittsburgh. He taught before the war at the Carnegie Institute of Technology, Pittsburgh, Pa.; Iowa State College, Ames; and Lehigh University, Bethlehem, Pa.

E. R. Whitehead (A '30, F '45) investigation engineer, Duquesne Light Company, Pittsburgh, Pa., has been named director of the department of electrical engineering at Illinois Institute of Technology, Chicago. Doctor Whitehead has been a half-time research professor of electrical engineering at the Institute and consultant in electrical engineering in general charge of the a-c network calculator at the Armour Research Foundation. Doctor Whitehead received his bachelor of science degree from the University of Colorado in 1928 and his master of science and doctor of philosophy degrees in 1935 and 1944 from the University of Pittsburgh. He has been associated with the Duquesne Company since 1932 and was electrical engineering lecturer in the industrial graduate study program at the University of Pittsburgh from 1940 to 1946. Doctor Whitehead has been particularly interested throughout his career in lightning protection for electric power systems. He is a member of Tau Beta Pi, Eta Kappa Nu, and Sigma Xi.

C. E. Smith (M '44) chief electrical engineer, Taylor-Winfield Corporation, Warren, Ohio, has received the 1946 AIEE national prize award for initial paper as coauthor of the paper, "Influence of Magnetic Materials on the Electric Welding Characteristics of Resistance Welding Machines." Mr. Smith attended Carnegie Institute of Technology. He was instrument repairman for Follansbee Brothers, Toronto, Ohio, for one year before joining the Westinghouse Electric Corporation, Pittsburgh, Pa., in 1937 as field engineer. In 1939 he was appointed design and development engineer in the electronic control apparatus department in East Pittsburgh. He became chief engineer for the Taylor-Winfield Corporation in 1942. Mr. Smith has been responsible for patent disclosures on welding control circuits, and ignitron rectifiers.

B. R. Teare (A '29, F '42) head of the department of electrical engineering and Buhl professor at Carnegie Institute of Technology, Pittsburgh, Pa., received the George Westinghouse award for distinguished contributions to engineering education from the American Society for Engineering Education. Doctor Teare's development of courses in engineering analysis and his work in the integration of humanistic and social studies and engineering education have been outstanding, according to Doctor Homer L. Dodge, chairman of the award committee. Doctor Teare received his bachelor of science and master of science degrees from the University of Wisconsin and his doctor of engineering degree from Yale University. He joined the Carnegie Institute faculty in 1939.

N. H. Callard (A '16) of Seattle, Wash., has been appointed manager of rural electrification, industry sales departments, Westinghouse Electric Corporation, East Pittsburgh, Pa. Mr. Callard recently returned from war service with the United States Navy and the Office of War Information in India. Prior to that he had been manager of the central station sales department of the company's Pacific Coast district and distribution apparatus manager of the agency sales department.

E. B. Finn (A '41) district sales manager, Insulation Manufacturers Corporation, Cleveland, Ohio; and **B. F. McNamara** (A '41) technical director of the corporation in Chicago, Ill.; have been appointed vice-presidents of the company. Mr. Finn, a 1920 graduate of Bowdoin College, has been with the company since 1927. Mr. McNamara, who attended the Newark College of Engineering, joined the company in 1930.

H. R. Osborne (A '27, M '44) formerly design engineer, Canadian General Electric Company, Ltd., Peterboro, Ontario, has been appointed chief engineer. A 1924 graduate of Queens University, Mr. Osborne was associated with the Westinghouse Electric Corporation, East Pittsburgh, Pa., from 1924 to 1930, before joining the Canadian General Electric Company. He is a member of the American Welding Society.

C. B. Kelley (A '23, M '30) electrical engineer of power plants, production department, Kansas City (Mo.) Power and Light Company, has been appointed power pool manager of the United Light and Railway Service Company. Mr. Kelley will control all operations of the 161,000-volt interconnecting transmission plant now being constructed by the six companies in the United System.

Vannevar Bush (A '15, F '24) president, Carnegie Institute of Washington, Washington, D. C., recently was awarded the honorary degree of doctor of science by Columbia University. The citation read in part: "inventor, as befits a Yankee; who, as chairman of the National Defense Research Council and director of the Office

N. H. Callard

C. E. Smith

D. W. Ver Planck

E. R. Whitehead

of Scientific Research and Development in World War II, guided America's men of science in creating a fortification of new discoveries, an arsenal of knowledge."

F. M. Tait (A '94, F '12) Dayton (Ohio) Power and Light Company, has received the honorary degree of doctor of science from the University of Dayton for "the talents and energy he has devoted to the construction, operation and administration of public utilities and the solution of human relations in industry."

L. E. Messinger (A '30, M '44) president and managing director, Canadian Line Materials, Ltd., and **T. W. Lawrence,** (A '19) president Sangamo Company, Ltd., recently were elected to the executive committee of the Ontario Division of the Canadian Manufacturing Association.

F. T. Wyman (A '12, F '21) president, Packard Electric Company, Ltd., St. Catherines, Ontario, Canada, recently was elected president of the city's Rotary Club.

F. W. Watts (A '24, F '45) who recently joined the Hart Manufacturing Company, Hartford, Conn., has been appointed general sales manager of the company. Mr. Watts formerly was vice-president of Great American Industries Inc., Meriden, Conn., and general manager of its subsidiaries Connecticut Telephone and Electric Division and Rutland Electric Products Division.

L. R. Brown (M '24) manager, transformer division, General Electric Company, Pittsfield, Mass., has retired. A graduate of the University of Wisconsin, Mr. Brown entered the General Electric test course in 1903. He was made head of the distribution section of transformer sales in 1911 and established the first commercial offices at Pittsfield in 1913. In 1923 he was appointed manager of transformer division. Among the important equipment changes in transformers instituted under Mr. Brown's direction was Pyranol, the first noninflammable insulating liquid.

C. O. Bicklehaupt (M '22, F '28) vice-president, American Telephone and Telegraph Company, New York, N. Y., who served as brigadier general in charge of communications in Europe during the war, recently was honored by the French Government for his contributions in engineering to that country. He was awarded the Medaille d'Officier d'Academie et de L'Instruction Publique by the French Ministry of Education.

C. E. Quinan (A '18, F '18) chief consulting engineer, Puget Sound Power and Light Company, Seattle, Wash., has retired. A 1910 graduate of the University of California, Mr. Quinan worked for a number of utility companies in the State of Washington before joining the Puget Sound Company. He became chief electrical engineer in 1919, chief engineer in 1935, and chief consulting engineer in 1942. Mr. Quinan was a vice-president of the AIEE for 1928–30.

F. A. Lewis

F. A. Lewis (A '31, M '35) formerly vice-president and director, Hooton Chocolate Company, Newark, N. J., has resigned to become an independent technical writer and publication consultant. Mr. Lewis was graduated from Syracuse University in 1926 with the degree of electrical engineer. He was associated with the Consolidated Edison Company of New York, Inc., and Bell Telephone Laboratories, Inc., before joining the AIEE editorial staff in 1931 as assistant. He was made associate editor in 1936 and served as acting editor from 1942 to 1945. He was appointed vice-president of the Hooton Company in 1945. He is a member of Tau Beta Pi.

H. B. Richmond (A '19, F '40) chairman of the board, General Radio Company, Cambridge, Mass., has been awarded the honorary degree of doctor of engineering by Norwich University for his pioneer radio service, his work on guided missiles in World War II, and his interest in engineering education.

D. F. Miner (M '34, F '40) formerly George Westinghouse Professor in the management engineering department, Carnegie Institute of Technology, Pittsburgh, Pa., has been appointed director of the division of student personnel and welfare at the institute. A graduate of Clark University and Worcester Polytechnic Institute, Doctor Miner joined the faculty of Carnegie Institute of Technology in 1938. Previously he had been manager of the engineering laboratory and standards department of the Westinghouse Electric Corporation, East Pittsburgh, Pa. He also has been assistant director of the college of engineering and science since 1945. He has served in both World Wars, in the second as lieutenant colonel in the Army Air Forces. He received the honorary degree of doctor of engineering in 1940 from the University of Pittsburgh.

E. K. Kraybill (A '40) assistant professor, Duke University, Durham, N. C., has been given a leave of absence to do doctorate work at the University of Michigan, Ann Arbor.

Otto Meier, Jr. (A '35, M '45) assistant professor, Duke University, Durham, N. C., has returned to the university after a leave of absence during which he did graduate work at the University of Pennsylvania, Philadelphia.

C. E. Oakes (M '46) president, Pennsylvania Power and Light Company, Allentown, Pa., has been elected president of the Edison Electric Institute.

K. A. Ganssle (A '40) of the operations and engineering department, American Telephone and Telegraph Company, New York, N. Y., has been placed in charge of a group handling central office and PBX equipment engineering work.

Austin Bailey (M '37) of the operations and engineering department, American Telephone and Telegraph Company, New York, N. Y., recently completed 25 years service with that company.

David Sarnoff (M '23) president, Radio Corporation of America, New York, N. Y., has been elected president of the Army Signal Association.

M. B. Long (A '19) assistant to the vice-president, Bell Telephone Laboratories, Inc., New York, N. Y., recently was elected one of six vice-presidents of the Telephone Pioneers of America.

F. M. Farmer (A '02, F '13) vice-president and consulting engineer, Electrical Testing Laboratories, Inc., has been appointed representative of the American Society for Testing Material on the Standards Council of the American Standards Association. **J. H. Foote** (A '18, F '32) supervising engineering, general engineering department, Commonwealth and Southern Corporation, Jackson, Mich., has been appointed additional alternate.

Peter Fries, Jr. (A '34) patent attorney, New York, N. Y., has returned from military service as Policy Officer on the staff of the Chief Signal Officer and Patent Officer on the staff of the Chief of Ordnance.

L. A. Helgesson (A '34) purchasing agent for the Iron Fireman Manufacturing Company, Portland, Oreg., for the past ten years has resigned. He has become purchasing agent and engineer with the Milwaukee Machinery Company, Portland.

C. L. Emerson (M '20, F '33) dean of engineering, Georgia School of Technology, Atlanta, received the 1947 distinguished service award of that school. Dean Emerson was honored as "eminent engineer, professional leader, faithful worker in civic affairs, and successful businessman."

H. H. Beverage (A '23, M '34) of RCA Laboratories, Radio Corporation of America, New York, N. Y., has been elected first vice-president of the New York Electrical Society.

V. E. Trouant (A '42) section engineer, RCA Victor Division, Radio Corporation of America, Camden, N. J., has been named manager of the company's broadcast and industrial section.

C. H. Nelson (A '27) formerly engineer for the Minnesota Taxation Department, Minneapolis, is now manager of the Light and Water Commission, Aitkin, Minn.

W. B. Loughty (M '42) adjustor for the Boiler Inspection and Insurance Company, Toronto, Ontario, Canada, has been appointed chief inspector for the company.

F. W. Godsey, Jr. (A '30, F '45) manager of the new products division, Westinghouse Electric Corporation, East Pittsburgh, Pa., has received the Yale Engineering Association Award for the advancement of basic and applied science.

Percy Dunsheath (F '22) consulting engineer, W. C. Henley's Telegraph Works Company, Ltd., London, England, has been elected an honorary member of the Engineering Institute of Canada.

H. H. Remine (A '24, M '35) formerly superintendent, electrical distribution department, Quebec Hydro-Electric Commission, Montreal, Canada, has been appointed assistant chief engineer of the operating division. **L. H. Marrotte** (M '46) formerly assistant superintendent of city stations for the Commission, has been appointed superintending engineer of substations.

A. L. Stevinson (A '46) who recently completed the test course at the Canadian General Electric Company, Ltd., Peterboro, Ontario, has been appointed to the induction motor section.

K. B. MacKichan (A '41) formerly assistant professor, Duke University, Durham, N. C., has been appointed head of the department of electrical engineering at the University of North Dakota, Grand Fork.

C. E. Miller

H. W. Rogers

G. W. Knapp

H. W. Rogers (A '12) has relinquished his duties as engineer of the paper and textile division, General Electric Company, Schenectady, N. Y., to become engineering consultant in the division. **G. W. Knapp** (A '45) formerly engineer, rubber and printing division, will succeed Mr. Rogers, and **C. E. Miller** (A '35, M '45) will occupy Mr. Knapp's former position. A graduate of Worcester Polytechnic Institute, Mr. Rogers has been with the company since 1906. Mr. Knapp entered the employ of the company after his graduation from Rensselaer Polytechnic Institute in 1936. Mr. Miller [illegible] been with the company since 1930.

J. W. Cofer (A '38) who has been serving as a colonel in the United States Army Engineers Corps, has joined the engineering department of the Toledo (Ohio) Edison Company. Before entering the Army, Mr. Cofer was an engineer with Ebasco Services, Inc., New York, N. Y.

C. M. Backer (A '36, M '43) has left the United States Navy Electronics Laboratory, San Diego, Calif., to accept a position with the Federal Telephone and Radio Corporation, Newark, N. J. Mr. Backer will be in the transmitter section of the radio engineering department.

S. B. Crary (A '31, M '45) engineer, analytical division, central station engineering division, General Electric Company, Schenectady, N. Y., and **W. J. McLachlan** (A '14, M '45) engineer, product division, central station engineering division, have been appointed assistant managers of the division. Mr. Crary is a graduate of Michigan State College and has been engineer in the analytical division since 1941. He was a recipient of the Charles A. Coffin Award in 1937. Mr. McLachlan, a graduate of Washington State College, has been with the company since 1924.

L. L. Glezen (A '22, M '29) telephone engineer, Bell Telephone Laboratories, Inc., New York, N. Y., recently completed 30 years with the company. **C. A. Bieling** (A '40), **B. R. Blair** (A '36), and **D. R. Brobst** (M '31), members of the technical staff of the laboratories, recently completed 24 years of service. **E. L. Alford** (A '29, M '36) member of the technical staff, has been with the laboratories for 20 years. **P. T. Sproul** (A '38, M '45) member of the technical staff, has finished his tenth year with the laboratories.

G. N. Tidd (A '00) president, American [illegible] Electric Service Corporation, New [illegible] N. Y., has been made chairman of the [illegible] of the company. Mr. Tidd has been [illegible] the American Gas Company, since it [illegible] organized in 1906. He was named vice-president and general manager in 1909, and president in 1923.

Norman Thornton (M '35) chief engineer of the Punjab Public Works Department, Electricity Branch, Lahore, India, recently was appointed secretary to the Government in the Electricity Department. Mr. Thornton is the AIEE honorary secretary for Northern India.

K. J. Ratliff (A '42) formerly sales engineer, Allis-Chalmers Manufacturing Company, San Antonio, Tex., has been named resident representative for the company's general machinery division at Fort Worth, Tex. Mr. Ratliff joined the company in 1945.

G. H. Phelps (M '45) division engineer, Westinghouse Electric Corporation, Baltimore, Md., has been named representative of the Radio Manufacturers Association in connection with the formation of the Radio Technical Commission for Marines, a new Government–industry agency.

Gano Dunn (A '91, HM '45) president, the J. G. White Engineering Corporation, New York, N. Y., was awarded the honorary degree of doctor of science by the College of the City of New York as part of its centennial celebration.

A. J. Sanial (M '43) has resigned as chief engineer of the Atlas Sound Corporation, Brooklyn, N. Y., to devote his time to consulting engineering work in the field of sound systems.

E. A. Damrau (A '24) formerly district manager, the Okonite Company, Pittsburgh, Pa., has been appointed manager of the company's new branch office in Charleston, W. Va.

H. C. Dean (A '12, F '30) vice-president of the Consolidated Edison Company of New York (N. Y.), Inc., has been elected president of the New York Electrical Society.

OBITUARY ● ● ● ●

Thomas D. Jones (A '31) district sales manager, Ohio Brass Company, Dallas, Tex., died May 24, 1947. Mr. Jones was born in Waco, Tex., February 28, 1891. His early electrical experience was gained with the Electric Appliance Company, Dallas, with which he was associated from 1913 to 1922. During World War I he served in France with the United States Signal Corps. Mr. Jones had been district sales manager for the Ohio Brass Company since 1922. He was active on numerous committees of the North Texas Section and had been chairman of the entertainment committee for 1942–43. He also was one of the original members of the Dallas Electric Club.

Justus Bulkley Entz (A '90) inventor of automotive devices, New Rochelle, N. Y., died June 8, 1947. Mr. Entz was born June 16, 1857, in New York, N. Y., and attended the College of the City of New York. In 1887 he joined the staff of the Edison Machine Works, Schenectady, N. Y., predecessor of the General Electric Company, and later became chief electrician. During his long career Mr. Entz was engineer for the Waddell-Entz Company, Bridgeport, Conn.; the Electric Storage Battery Company, Philadelphia, Pa.; the Electric Vehicle Co., Hartford, Conn.; the White Motor Company, Cleveland, Ohio; and the Entz-Motor Patent Corporation, New York. He held patents on approximately 75 automotive devices, including the starters used by the White Company trucks and the Franklin and Chalmers automobiles. He was a member of the Society of Automotive Engineers, the Edison Pioneers, and the Engineers Club of New York.

John Van Veen (A '20, M '28) assistant manager, electric department, Cincinnati (Ohio) Gas and Electric Company, died June 9, 1947. Mr. Van Veen was born in Amsterdam, The Netherlands, June 15, 1888, and was educated in The Netherlands. He came to the United States in 1913 and joined the predecessor of the Cincinnati Company as an electrician with the electric production department. He was made chief electrician of production in 1916 and superintendent of the electric operating department in 1926. He had been assistant manager of the electric department since 1946. Mr. Van Veen was a member of the Cincinnati Engineers Club and the Society of Professional Engineers.

John Henry Morice (A '12) sales engineer, Canadian General Electric Company, Ltd., Toronto, Ontario, died February 17, 1947. Born January 5, 1885, in Stratsford, Ontario, Mr. Morice was graduated from the University of Toronto, with the degree of bachelor of applied science. He entered the test course of the General Electric Company at Pittsfield, Mass., and following that was transferred to the switchgear engineering department in Schenectady, N. Y. He afterwards was assigned to the company's offices in San Francisco, Calif., and Philadelphia, Pa. He joined the Canadian Company in 1929. For a number of years he was Toronto and district representative of the Taylor Electric Company of London, Ontario. He returned to the Canadian General Electric Company in 1943.

Jens Ludwig Diemer-Hansen (A '07, M '10) manufacturers representative, Denver, Colo., died April 24, 1947. Mr. Hansen, who was born, June 5, 1870, in Copenhagen, Denmark, was graduated from the Royal Danish Navy Electrical College and worked in Denmark until 1899. He then became associated with the Siam Electricity Company, Bangkok, and, while with that utility, was decorated by the King of Siam for outstanding service to the nation. Mr. Hansen came to the United States in 1917 and served as chief engineer of the Ashton and St. Anthony (Idaho) Power Company. In 1922 he established a consulting practice in Denver. He was a member of the Institution of Electrical Engineers.

John T. Shay (A '18) retired engineer, Consolidated Edison Company of New York (N. Y.), Inc., died April 28, 1947. Mr. Shay was born in New York in 1867 and joined the United Electric Light and Power Company, predecessor of the Consolidated Company in 1892. At the time of his retirement in 1932 he was general foreman.

Frederick A. O'Sullivan (A '19) general superintendent, Edwin C. Lewis, Inc., Boston, Mass., died May 18, 1947. Mr. O'Sullivan was born July 2, 1874, in Newtonville, Mass. Before joining the Lewis Company in 1905, he was associated with the Godfrey Electric Construction Company and with the Barnes Electric Company.

MEMBERSHIP ● ●

Recommended for Transfer

The board of examiners, at its meeting of June 19, 1947, recommended the following members for transfer to the grade of membership indicated. Any objection to these transfers should be filed at once with the secretary of the Institute.

To Grade of Fellow

Doble, F. C., pres. & treas., Doble Engg. Co., Medford Hillside, Mass.
Grondahl, L. O., director, research & engg., Union Switch & Signal Co., Swissvale, Pa.
Kittredge, L. E., equipment & building engr., American Tel. & Tel. Co., New York, N. Y.
Levy, D. H., genl. supt., tel. & tel. dept., Magnolia Pipe Line Co., Dallas, Tex.
Lunsferd, J. B., head engr., Bureau of Ships, U. S. Navy Dept., Washington, D. C.
Reed, H. R., chief telephone engr., Stromberg-Carlson Co., Rochester, N. Y.
Walker, E. A., head, dept. of elec. engg.; director, ordnance research lab., Pennsylvania State College, State College, Pa.

7 to grade of Fellow

To Grade of Member

Aitken, D. R., Jr., asst. elec. supt., chg. North Fabricating Plant, Aluminum Co. of America, Alcoa, Tenn.
Belknap, M. M., elec. engr., Iowa Elec. Lt.& Pr. Co., Boone, Iowa.
Bianchi, R., elec. engr., national ordnance lab., Naval Gun Factory, Washington, D. C.
Bishop, H. W., Jr. engr., applied physics lab., Johns Hopkins Univ., Silver Spring, Md.
Buck, H. L., treas., I-T-E Circuit Breaker Co., Phila., Pa.
Bueno, M. P., elec. engr., Westinghouse Elec. Intl. Co., New York, N. Y.
Carter, W. L., exchange trans. engr., Pacific Tel. & Tel. Co., San Francisco, Calif.
Caspar, R. B., asst. engr., Public Service Elec. & Gas Co., Newark, N. J.
Cheek, R. C., central station engr., Westinghouse Elec. Corp., East Pittsburgh, Pa.
Clark, J. J., Jr., section mgr., Westinghouse Elec. Corp., Phila., Pa.
Coffin, L. H., assoc. elec. engr., Cincinnati Gas & Elec. Co., Cincinnati, Ohio.
D'Agostino, V. F., transmission networks engr., Western Elec. Co., Kearny, N. J.
Donnelly, J. B., elec. engr., Dept. of City Transit, Phila., Pa.
Eastin, M. R., eastern zone mgr., railway controls div., Minneapolis-Honeywell Reg. Co., New York, N. Y.
Egan, V. J., motor & generator application engr., Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Ferry, J. H., executive vice-pres., Potomac Elec. Pr. Co., Washington, D. C.
Foster, L. W., elec. engr., General Elec. Co., Pittsfield, Mass.
Gaugler, E. A., physicist, naval ordnance lab., Navy Gun Factory, Washington, D. C.
Harris, F. K., physicist, National Bureau of Standards, Washington, D. C.
Hart, G. F., asst. elec. engr., Bangor Hydro-Electric Co., Bangor, Maine.
Healey, W. C., mgr., Dallas branch, Westinghouse Elec. Corp., Dallas, Tex.
Helwith, E. E., elec. engr., system engg. staff, Bonneville Power Adm., Portland, Oreg.
Hostetter, J. W., asst. prof. elec. engg., Polytechnic Inst. of Bklyn., Brooklyn, N. Y.
Hrabak, R. A., consulting engr., Traverse City, Mich.
Jacobsen, C. R., engr., Commonwealth & Southern Corp., Jackson, Mich.
Kehoe, L. F., consulting engr., electrical, Baraboo, Wis.
Kerr, W. H., dist. mgr., Lodi dist., Pacific Gas & Elec. Co., Lodi, Calif.
Kilgour, A. E., application engr., Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Larson, L. R., head, systems & applied research sec., Naval Research Lab., Washington, D. C.
Lauchland, L. S., asst. prof. elec. engg., Univ. of Toronto, Ontario, Canada.
McClinton, A. T., elec. engr., Naval Research Lab., Washington, D. C.
McKinley, G. L., engr., Chesapeake & Potomac Tel. Co., Washington, D. C.
McLaughlin, J. W., elec. engr., Bureau of Reclamation, Dept. of Interior, Washington, D. C.
McNaughton, E. F., director, utilities dept., Calif. Public Utilities Comm., San Francisco, Calif.
Moorhouse, C. E., design engr., Canadian Westinghouse Co. Ltd., Hamilton, Ontario, Canada.
Moyers, W. R., Jr., chief substation engr., Memphis Lt., Gas & Water Div., Memphis, Tenn.
Nettell, F. L., technical asst., Pacific Gas & Elec. Co., Santa Rosa, Calif.
Parsons, J. S., distribution engr., Westinghouse Elec. Corp., East Pittsburgh, Pa.
Rice, R. E., dept. head, Western Elec. Co., Kearny, N. J.
Robb, D. E., branch chief, radio noise branch, Components & Systems Lab., Wright Field, Dayton, Ohio.
Schneider, W. R., asst. engr., bureau of tests & inspections, Pacific Gas & Elec. Co., Emeryville, Calif.
Schultz, N. R., application engr., General Elec. Co., Schenectady, N. Y.
Scott, D. H., elec. engr., Naval Research Lab., Washington, D. C.
Scott, J. A., elec. engr., U. S. Engineers, Hq. MANED, c/o P.M., San Francisco, Calif.
Segall, B., elec. distribution engr., New Orleans Public Service, New Orleans, La.
Sittloh, C. F., elec. engr., Alabama Power Co., Birmingham, Ala.
Smith, H. D., design section, transportation control engg. dept., General Elec. Co., Erie, Pa.
Steinert, W. E., senior staff engr., Bell Tel Co. of Pa., Phila., Pa.
Steinhauser, C. P., patent engr., Philips Laboratories, Inc., Irvington-on-Hudson, N. Y.
Thompson, R. J., chief engr., Trumbull Elec. Mfg. Co., Hollywood, Calif.
Thoren, A. V., resident engr., Travelers Ins. Co., Duluth, Minn.

Titus, C. H., development engr., General Elec. Co., Phila., Pa.
Varney, B. F., supervisor, elec. projects, North American Aviaton, Inc., Los Angeles, Calif.
Verdier, W. H., engr., applied physics lab., Johns Hopkins Univ., Silver Spring, Md.
Walker, J. F., chg. of transportation div., General Elec. Co., New Haven, Conn.
Wallace, P. G., supervisor design div., Texas Pr. & Lt. Co.,Dallas, Tex.
Welch, A. U., Jr., division engr., General Elec. Co., Holyoke, Mass.
White, T. F., asst. supt. construction, Texas Pr. & Lt. Co., Dallas, Tex.

58 to grade of Member

Applications for Election

Applications have been received at headquarters from the following candidates for election to membership in the Institute. Any member objecting to the election of any of these candidates should so inform the secretary before August 21, 1947, or October 21, 1947, if the applicant resides outside of the United States or Canada.

To Grade of Fellow

Moore, E. T. (re-election), Peter F. Loftus Corp., Pittsburgh, Pa.

1 to grade of Fellow

To Grade of Member

Baker, G. M. K., RCA, Princeton, N. J.
Bowles, F., The Imperial Tobacco Co., Ltd., Bedminster, Bristol, England.
Brumby, W. W., English Elec. Co. of Canada, Ltd., St. Catharines, Ontario, Canada.
Cambridge, C. G., Watson Lab., Red Bank, N. J.
Cavanaugh, H. M., Hyre Elec. Co., Chicago, Ill.
Clough, Karl E., The Dictaphone Corp., Kansas City, Mo.
Cole, C. C., Western Elec. Co., Chicago, Ill.
Coles, E. M., Canadian Westinghouse, Hamilton, Ontario, Canada.
Crocker, J. A., Reed Research, Inc., Washington, D. C.
Cusack, F. H., Western Union Tel. Co., New York, N. Y.
Darst, W. H., Jr., United Engineers & Constructors, Inc., Philadelphia, Pa.
Dharmarajan, N., c/o The Ontario Hydro-Elec. Power Comm., Toronto, Ont., Canada.
Goar, R. M., General Elec. Co., Kansas City, Mo.
Guha, H. C., Jadavpur Engg. College, Parganas, Bengal, India.
Hays, L. K., Wagner Elec. Co., Miami, Fla.
Kostkos, H. J., Bell Tel. Labs., Inc., New York, N. Y.
Kurtz, H. J., Ohio River Div. Labs. (War Dept.), Mariemont, Ohio.
Le Feber, A., 713 Temple Bar Bldg., Cincinnati, Ohio.
McCurdy, J. D., Coverdale & Colpitts, New York, N. Y.
McKinney, H. H., Naval Station, Tacoma, Wash.
Montgomery, J. L., 1917 N. La Salle St., Indianapolis, Ind.
Mueller, E. J., Intl. Harvester Co., Memphis, Tenn.
Newton, B. G., U. S. Atomic Energy Comm., Oak Ridge, Tenn.
Randall, C. S., Potomac Elec. Pr. Co., Washington, D. C.
Sparks, R. E., 3670 Westwood Blvd., Los Angeles, Calif.
Tull, W. S., Deleuw, Cather & Co., Chicago, Ill.
Wagner, B. S., The Cincinnati & Suburban Bell Tel. Co., Cincinnati, Ohio.
Wakefield, E. H., Abbey Elec. Co., Chicago, Ill.
Winterburn, F., Howard Smith Paper Mills, Ltd., Cornwall, Ontario, Canada.
Womack, F. C., El Paso Elec. Co., Las Cruces, N. Mex.

30 to grade of Member

To Grade of Associate

United States, Canada, and Mexico

1. North Eastern

Bangs, G. L., (re-election), Rochester Gas & Elec. Corp., Rochester, N. Y.
Brennan, F. L., Stone & Webster Engg. Corp., Boston, Mass.
Cloyes, H. S., N. Y. Tel. Co., Albany, N. Y.
Conley, G. H., Jr., 253 High St., Newburyport, Mass.
Crawford, S. N., General Elec. Co., Schenectady, N. Y.
Halsey, G. H., General Elec. Co., Pittsfield, Mass.
Hamilton, D., N. Y. State Elec. & Gas Corp., Elmira, N. Y.
Lenz, J. E., General Elec. Co., Holyoke, Mass.
Manieri, P. F., IBM Corp., Endicott, N. Y.
O'Neil, S. J., Watson Labs., Cambridge, Mass.
Orear, E. R., Mass. Inst. of Tech., Cambridge, Mass.
Personius, W. W., N. Y. State Elec. & Gas Corp., Elmira, N. Y.
Porterfield, F. B., IBM Corp., Endicott, N. Y.
Sarley, J. M., IBM Corp., Endicott, N. Y.
Ungvary, R. L., Yale Univ., New Haven, Conn.

2. Middle Eastern

Amey, W. G., Leeds & Northrup Co., Philadelphia, Pa.
Barry, E. P., Westinghouse Elec. Corp., Sharon, Pa.
Bauer, M. G., Pioneer Radio Supply Co., Cleveland, Ohio.
Diehl, C. S., General Elec. Co., Cleveland, Ohio.
Greenlee, A. B., Jr., Chesapeake & Potomac Tel. Co., Charleston, W. Va.
Gross, M., General Elec. Co., Cleveland, Ohio.
Guttinger, W., Reliance Elec. & Engg. Co., Cleveland, Ohio.
Hartley, R. H., Westinghouse Elec. Corp., East Pittsburgh, Pa.
Henry, D. L., Propellor Lab., Wright Field, Dayton, Ohio.
Horst, W. J., Keystone Portland Cement Co., Bath, Pa.
Jackson, J. T., Wagner Elec. Co., Washington, D. C.
Jancin, J., Jr., IBM Corp., Cleveland, Ohio.
Johnston, A. T. (re-election), Union Switch & Signal Co., Swissvale, Pa.
Mase, W. J., Battelle Memorial Institute, Columbus, Ohio.
Randolph, R. F., Elliott Co., Jeanette, Pa.
Rexroad, H. N., West Virginia Univ., Morgantown, W. Va.
Wilken, E. E., Nazareth Cement Co., Nazareth, Pa.

3. New York City

Barnes, H. C., American Gas & Elec. Service Co., New York, N. Y.
Bates, R. E., Consolidated Edison Co., Brooklyn, N. Y.
Cornell, L. A., Watson Labs., Eatontown, N. J.
Elkind, A. H., 85 Highland Avenue, Yonkers, N. Y.
Erikson, C. F., Nathan Aircraft Devices, Inc., New York, N. Y.
Hennesy, E. P., Westinghouse Elec. Co., Newark, N. J.
Hollingsworth, D. L., Underwriters Labs., New York, N. Y.
Jawitz, J., Jabro Supply Co., New York, N. Y.
Kolb, A. L., General Cable Corp., New York, N. Y.
McMahon, W. T., Bell Tel. Labs., Inc., New York, N. Y.
Shafer, W. L., Jr., Bell Tel. Labs., Inc., New York, N. Y.
Schryber, E. A., David E. Kennedy, Inc., Brooklyn, N. Y.
Stelle, D. R., Standard Oil Dev. Co., Elizabeth, N. J.
Sternad, W. J., (re-election), Goetze Gasket & Packing Co.; New Brunswick, N. J.
Wheeler, T. J., Gibbs & Cox, Inc., New York, N. Y.
White, E. S., R.C.A. Industries Service Div., New York, N. Y.

4. Southern

Avery, F. B., Southern Bell Tel. & Tel. Co., Baton Rouge, La.
Campbell, G. B., Commonwealth & Southern Corp., Birmingham, Ala.
Cole, M. W., Engleby Elec. Co., Roanoke, Va.
David, C. J., Southern Bell Tel. & Tel. Company, Baton Rouge, La.
Dowling, H. M., James M. Todd, New Orleans, La.
Garrette, C. H., Jr., B. O. Vannort, Charlotte, N. C.
Gulliford, W. I., Reliance Elec. & Engg. Co., Roanoke, Va.
Hogue, T. J., Jr., Southern Bell Tel. & Tel. Co., Lafayette, La.
McIntire, R. K., The Solvay Process Co., Baton Rouge, La.
Rosenthal, S., TVA, Chattanooga, Tenn.
Shands, G. K. (re-election), Virginian Railway Co., Narrows, Va.
Stewart, M. K., Carolina Pr. & Lt. Co., Raleigh, N. C.
Streever, O. J., Newport News Shipbuilding & Drydock Co., Newport News, Va.
Tedder, Charles C., Roane-Anderson Co., Oak Ridge, Tenn.
Wetherington, J. R., The Springs Cotton Mills, Lancaster, S. C.

5. Great Lakes

Buenik, F. G., Electro-Motive Div., GMC, La Grange, Ill.
Dalasta, D., Allis-Chalmers Mfg. Co., Wauwatosa, Wis.
Goldberg, L., Automatic Elec. Co., Chicago, Ill.
Heinlein, E. W., State of Ill. Highway Dept., Springfield, Ill.
Kresnicka, I. J., Western Elec. Co., Chicago, Ill.
Paden, C. W., DeForest Training, Inc., Chicago, Ill.
Rakes, R. H., Commonwealth Edison Co., Chicago, Ill.
Rugg, A. P., Kearney & Trecker Corp., West Allis, Wis.
Sampedro, G. R., Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Sankovic, D. J., Electro-Motive Div., GMC, La Grange, Ill.
Skelly, J. J., Shell Oil Co., Inc., Wood River, Ill.
Smith, W. L., Univ. of Wisconsin, Madison, Wis.
Thomsen, T. R., Weltronic Co., Detroit, Mich.
Watts, A. W., Western Elec. Co., Inc., Chicago, Ill.
Wilcox, M. L., Univ. of Notre Dame, Notre Dame, Ind.
Wilson, H. R., Allis-Chalmers Mfg. Co., West Allis, Wis.
nnette, J. G., Allis-Chalmers Mfg. Co., West Allis, Wis.
Zajec, J. M., Sinclair Refining Co., East Chicago, Ind.

7. South West

Amador, O. W., Gorman Eng. Co., El Paso, Tex.
Buck, A. F., Westinghouse Elec. Corp., St. Louis, Mo.
Dyer, G. C., Sterett Supply Co., Corpus Christi, Tex.
Forbes, E. K., Dow Chemical Co., Freeport, Tex.
Grubb, T. L., Beech Aircraft Corp., Wichita, Kans.
Hamilton, L. E., Southwest Engrs., Inc., Dallas, Tex.
Peyton, N. C., El Paso Elec. Co., El Paso, Tex.
Rice, S., Roberts Tractor Co., Inc., Dodge City, Kans.
Ruede, J. E., Elec. Machinery Repair Shop, Mexico, D. F., Mexico.
Smith, J. E., Westinghouse Elec. Corp., St. Louis, Mo.
Steiner, W. J. F., Cia Distribuidora Westinghouse, Mexico, D. F., Mexico.
White, L. T., El Paso Saw & Belting Supply Co., El Paso, Tex.

8. Pacific

Ariey, A. F., Pacific Gas & Elec. Co., Martinez, Calif.
Baubel, F. C., IBM Corp., San Francisco, Calif.
Byerly, C. M., Gilfillan Bros., Inc., Los Angeles, Calif.
Cassasa, S. F., Pacific Tel. & Tel. Co., San Francisco, Calif.
Christensen, H. S., So. Calif. Edison Co., Los Angeles, Calif.
Edwards, H. L., Pacific Tel. & Tel. Co., San Francisco, Calif.
Edwards, R. F., Univ. of California, Berkeley, Calif.
Eichner, L. A., Univ. of California, Berkeley, Calif.
Emerson, T. B., Pacific Tel. & Tel. Co., San Francisco, Calif.
Faber, A. C., Dept. of Water & Pr., Los Angeles, Calif.
Greer, R., Pacific Gas & Elec. Co., Red Bluff, Calif.
Handley, L. R., Westinghouse Elec. Supply Co., Los Angeles, Calif.
Kert, M. A., U. S. A. T. Admiral C. F. Hughes, Ft. Mason, San Francisco, Calif.
Kirkhart, K., Pacific Tel. & Tel. Co., Anaheim, Calif.
Scolari, M. W., Westinghouse Elec. Corp., San Francisco, Calif.
Sperry, M. M., Pacific Gas & Elec. Co., Marysville, Calif.
Stotsky, J. S., U. S. Army, Dept. of Commerce, USAMGIK, APO 235-2, PM San Francisco, Calif.
Taylor, B. E., Pacific Tel. & Tel. Co., San Francisco, Calif.

9. North West

Birkes, R. C., Pacific Pr. & Lt. Co., Portland, Oreg.
Browning, C. L. Swett & Crawford Co., Portland, Oreg.
Moran, J. H., Anaconda Copper Mining Co., Great Falls, Mont.

10. Canada

Crawshaw, W. H., Morganite Carbon Products Canada, Ltd., Toronto, Ontario, Canada.
Kert, M. H., Canadian Domestic Engg. Co., Ltd., Montreal, Quebec, Canada.
Osborn, H. G., Electro-Metallurgical Co., Welland, Ontario, Canada.

Elsewhere

Bhargava, A. N., I B Ganges Canal Hydel Scheme, Roorkee, United Provinces, India.
Boyer, R. M., Puerto Rico Water Resources Authority, San Juan, Puerto Rico.
Burbage, A. G., F & W Branch, Army HQ, Wellington, New Zealand.
Domenech, J., Lt. U. S. Army, L.A.T.C.-G.D. Fort Amador, Canal Zone.
Flack, D. C., Bristol Aeroplane Co., Ltd., Filton, Bristol, England.
Franqui, A., Puerto Rico Water Resources Authority, San Juan, Puerto Rico.
Freeman, C. F., Messrs. Courtaulds, Ltd., Coventry, England.
Garcia, V. M., Puerto Rico Water Resources Authority, Santurce, Puerto Rico.
Hughes, J. C., Int. General Elec. Co., San Juan, Puerto Rico.
Irizarry, F., Jr., Dept. of the Interior, Santurce, Puerto Rico.
Lindstrom, L. L., Int. General Elec. Co., San Juan, Puerto Rico.
Liompart, J. J., Puerto Rico Water Resources Authority, San Juan, Puerto Rico.
Matos, J. A., Puerto Rico Water Resources Authority, San Juan, Puerto Rico.
Ogilvie, A. M., Central Electricity Board, Letch Lane, Carlton, Stockton-on-Tees, England.
Pla, I. L., Puerto Rico Water Resources Authority, San Juan, Puerto Rico.
Sharma, G. S., The Farrukhabad Elec. Supply Co., Ltd., Fatehgarh, United Provinces, India.
Skerrett, H. (re-election), Puerto Rico Water Resources Authority, San Juan, Puerto Rico.
Stanley, R. L., Messrs. Johnson & Phillips, Charlton, Kent, England.
Vere, O., Puerto Rico Water Resources Authority, San Juan, Puerto Rico.
Whitworth, R. H., R.A.F., Annesley, Nottingham, England.

Total to grade of Associate
United States, Canada, and Mexico, 117
Elsewhere, 20

OF CURRENT INTEREST

ASME Semiannual Meeting Held in Chicago, July 15-19

The semiannual meeting of the American Society of Mechanical Engineers was held this year at the Hotel Stevens, Chicago, Ill., June 15–19, 1947. More than 1,200 people attended, participating in 32 technical sessions and a number of other events, including luncheons and a banquet. Officers for 1947–48 were nominated. Some of the items covered during the meeting are reviewed briefly in the following.

ROCKETS

The problems of rocket construction materials and fuels and controls for interplanetary flight were discussed by Doctor J. M. Zucrow, professor of jet propulsion and gas turbines at Purdue University, Lafayette, Ind. At the same session, Colonel Philip B. Klein of the Air Matériel Command described the army's rocket-powered *XS-1* and other research aircraft designed for high subsonic and supersonic flights.

ATOMIC ENERGY

Various aspects of atomic energy were discussed at another session. Doctor Alfred O. C. Nier, professor of physics at the University of Minnesota, addressed a session devoted to atomic power engineering on "Some Nuclear Problems." Bruce R. Prentice, of the engineering policy division of General Electric Company, Schenectady, N. Y., spoke on "Some Design Problems." It was said that engineers can make substantial contributions toward making atomic energy an every day reality by merely extending their scope of operations. In general, atomic energy for power plants is waiting for the joint efforts of the engineer and the physicist, especially in the field of new materials.

COAL TOPICS

Doctor Harold J. Rose, vice-president and director of research for Bituminous Coal Research, Inc., Pittsburgh, Pa., addressed the society, saying that coal reserves in this country are so enormous that they can supply all our requirements for the next 1,500 years. Technical developments have been so rapid that coal now can be used to produce almost any type of solid, liquid, or gaseous fuel or synthetic chemical product.

A recent engineering development in the production of char from coking bituminous coal which will make this product desirable for steam and power generating stations was described in a paper by A. D. Singh, president of the Singh Company, Chicago, Ill., and L. J. Kane, chemical engineer with the Bureau of Mines. The application of the fluidization process to devolatilization of coking bituminous coal was described, with specific results presented on Kincaid coal from seam number 6, Christian County, central Illinois. The paper concluded that the process seems to offer excellent opportunity for combined gas and utility systems, and that the technological difficulties which prevented successful production of power char from finely crushed coal in previous investigations have been overcome effectively by the application of the fluid technique and other improvements.

AVIATION

Greater comfort for air passengers was predicted in a paper by John B. Schwab, accommodation engineer of Trans-Canada Airlines, Dorval, Quebec, Canada. The Engineering Institute of Canada was cosponsor of the session. Mr. Schwab pointed out that to survive competition, air transportation must provide comfort of travel, equal to, if not better than, surface transportation facilities. Among other features, the ideal luxury passenger cabin of the future will have a backward seating arrangement for its passengers which will afford them a better view and added protection in the event of a forced landing, cabin pressurization, better interior design with a special regard to color and improved lighting arrangements, more economical food services, and quieter operation. Noise and vibrations, emergency equipment, and crew personnel also were discussed.

FREE COMPETITION

Among the nontechnical discussions of interest was a talk by Charles E. Wilson, president of General Motors Corporation, Detroit, Mich., who voiced a plea for affirmation of faith in a liberal and free competitive system, and warned against the effort to find political short-cuts to prosperity without work.

"GROUPITIS"

L. J. Fletcher, Caterpillar Tractor Company executive, Peoria, Ill., described "groupitis" a disease which divides people into an increasing number of groups, each devoted to one selfish interest, which threatens the world with economic chaos. He recommended that the engineer should take more part in general affairs of his locality, including politics.

MANAGEMENT

At a management session, John A. Patton, Chicago management engineer, voiced the opinion that management must carry the main burden of creating and maintaining good labor relations, and that it can do this only by establishing lines of communications with the workers. The breakdown of such lines, he said, is less dramatic but just as crippling to industry as the recent telephone strike. Without them industrial peace never can be achieved.

COLLECTIVE BARGAINING

Noteworthy among the nontechnical discussions was an address by Eugene W. O'Brien of Atlanta, Ga., president of the American Society of Mechanical Engineers, who discussed the engineer and collective bargaining, and an over-all engineering society. He quoted statistics from the Engineers Joint Council report on national labor legislation, citing results of the questionnaire poll regarding the exemption of professional employees from the provision of the national labor relations act. He foresaw improved economic and professional status for the engineering profession, and opportunities for public service through increased co-operation of national engineering societies.

OFFICERS NOMINATED

New officers of the American Society of Mechanical Engineers were nominated at the semiannual meeting. As only one nominee is named for each office, nomination is tantamount to election. The officers so designated are: *president*, E. G. Bailey, vice-president of the Babcock and Wilcox Company, New York, N. Y.; and *regional vice-presidents*, Frank M. Gunby, associate of Charles T. Main, Inc., Boston, Mass., (region 1); Paul B. Eaton, head of the mechanical engineering department of Lafayette College, Easton, Pa., (region 3); Thomas E. Purcell, general superintendent of power stations, Duquesne Light Company, Pittsburgh, Pa., (region 5); and J. Calvin Brown, head of the firm of J. Calvin Brown, Los Angeles, Calif. (region 7). A board of directors also was named.

New EJC Committee to Aid State Department

Closer liaison between the engineering profession and Federal agencies devoted to better international relations is the object of a special committee recently appointed by the Engineers Joint Council. This body is to be made up of one representative from each of the five constituent societies of the Council. It will be a consultative committee to the State Department and to the EJC committee on international relations, of which Malcolm Pirnie, New York, N. Y., past president of the American Society of Civil Engineers, is chairman.

The committee was authorized by EJC

following the appearance before it of E. Theodore Arndt, who attended the meeting as an observer representing William Benton of the State Department. Mr. Arndt lauded the co-operation which the State Department has had from the EJC committee on international relations and declared that there is increasing need for liaison between the State Department and the engineering profession. The State Department has been receiving requests from foreign countries for engineering knowledge, and it would like to have the advice of engineers on how to handle these requests. The recent election of EJC to the United Nations Educational, Scientific, and Cultural Organization was a step forward in the right direction to recognize the contribution that engineers can render in the rehabilitation of the world.

Members of the consultative committee appointed are: E. M. Hastings, American Society of Civil Engineers; W. E. Wickenden (F '39), AIEE; Clyde Williams, American Institute of Mining and Metallurgical Engineers; D. E. Yarnall, American Society of Mechanical Engineers; and James G. Vail, American Institute of Chemical Engineers. Chairman Pirnie of the International Relations Committee pointed out that availability of the members of this consultative committee will be helpful when requests for assistance are made by the State Department on short notice, for it is expected that, with the enlarged personnel, personal assistance of at least some members of the committee will be available at all times.

Army Signal Association Organizes Philadelphia Chapter

Organized to stimulate interest in communication preparedness bearing on national defense, the Philadelphia chapter of the Army Signal Association was presented formally with its official charter on June 16, 1947, by Colonel Elton Hammond, acting for the Army Chief Signal Officer.

Newly elected officers of the organization include: *president*, W. W. Watts, vice-president of the Radio Corporation of America in charge of the RCA Engineering Products Department, Camden, N. J.; *first vice-president*, C. R. Freehafer (M '40) vice-president and general manager, Eastern area, Bell Telephone Company of Pennsylvania; *second vice-president*, W. H. Knowles, chief engineer, International Resistance Company; *secretary*, G. O. Peters, electrical engineer, Army Communications Service Division, Signal Corps Plant Engineering Agency; and *treasurer*, W. F. Denkhaus (M '40) assistant engineer, Eastern area, Bell Telephone Company of Pennsylvania.

Accepting the charter for the Philadelphia group of leading communication experts, Mr. Watts stressed the importance of close co-operation between industry and the Army Signal Corps to insure maximum military preparedness of the United States. He especially emphasized the proximity of the local chapter to the Signal Corps Procurement and Supply Control Activities located in Philadelphia. Major General Harry C. Ingles, former Chief Signal Officer of the United States Army, and director of the RCA Institute, discussed the rôle of technical education in the over-all military preparedness of the country.

Microwave Relay Circuit Ready for Television

The General Electric Company has a 1-way microwave radio relay circuit ready for commercial television operation between New York, N. Y., and Schenectady, N. Y., and will extend the circuit to Syracuse, N. Y., if these plans are approved by the Federal Communications Commission.

The new relay operates in the 2,000-megacycle region. Extremely directional, the microwaves are beamed from a transmitter atop the General Electric office building at 570 Lexington Avenue, New York City, to a relay station on Beacon Mountain 55 miles north of New York. From there they travel 55 miles to Round Top Mountain where another relay tower transmits them 29 miles to the Helderberg mountains. Picked up by a third relay tower there, the signals are sent 14 miles to the Schenectady terminus.

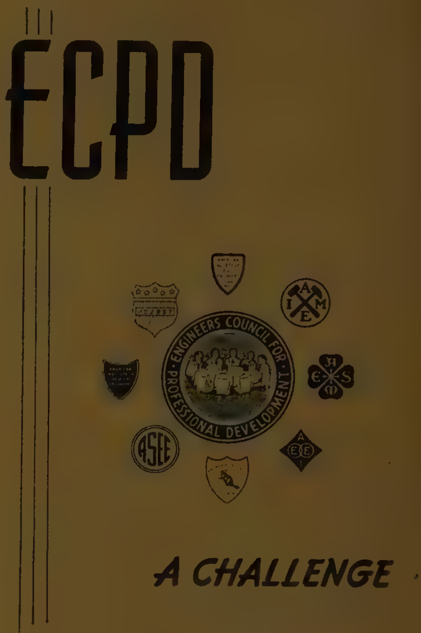
At present the microwave relay circuit uses separate carriers for the sound and picture components of the signal. However, it is planned to convert the present system so as to require use of only one of the microwave channels for handling both aural and visual signals. This will be done by adding multiplexing equipment at the two terminals. Incorporated in production equipment, this multiplexing equipment greatly would reduce the cost of constructing the television relay, as well as lower the operating costs of transmitting programs. The company has been relaying television programs from New York City for the past seven years on an experimental basis.

Stewart, Engineering Index Head, Dies. Frank Y. Stewart, president of Engineering Index, Inc., a research and annotation publishing service at 29 West 39th Street, New York, N. Y., died on June 5, 1947, at the age of 75. He joined the Engineering Index in 1929 and, after serving as vice-president and business manager, became president last February. He was a member of the American Society of Mechanical Engineers.

ECPD—A Challenge

The Engineers Council for Professional Development has released a 16-page 2-color brochure celebrating the 15th anniversary of its founding entitled "ECPD—A Challenge." The booklet covers the history of the growth and the need for ECPD, ECPD's development, its present projects, and its future growth.

Among the interesting items included in the publication is a map indicating the influence of ECPD as exerted by the sponsoring societies of local chapters. Accredited schools, accredited programs, and student guidance programs are listed. A discussion of the need for future engineers also is included.


ECPD
ENGINEERS COUNCIL FOR PROFESSIONAL DEVELOPMENT
A CHALLENGE

Cover of new ECPD booklet

The booklet is available from the Engineers Council for Professional Development, 33 West 39th Street, New York 18, N. Y., at 25 cents per copy.

Government Exhibits at Instrument Show. Several Government departments are preparing exhibits for the Second Annual Instrument Exhibit, sponsored by the Instrument Society of America, which will be held at the Stevens Hotel, Chicago, Ill., September 8–12, 1947. The Army Ordnance Department of the United States Army, the National Bureau of Standards, the Naval Ordnance Laboratories, and the United States Weather Bureau, as well as some 140 instrument manufacturers, will demonstrate and explain the latest instrument developments during that week.

Lighting Exposition Award Competition. More than 300 entries are expected in the Second International Lighting Exposition Merit Award Competition according to estimates made by the Merit Award Committee. All entries accepted by the board of five judges will be awarded

Merit Award certificates and will be given prominent display at the exposition which will be held November 3–7, 1947, at the Stevens Hotel in Chicago, Ill. In addition, the total cash awards will be $1,200, with three $100 awards going to each of the following eligible groups: electrical contractors, electrical wholesalers, architects and consulting engineers, and utility lighting and power men. Those desiring to enter the competition should write for the official rules book and entry blank to the Merit Award Committee, 326 West Madison Street, Chicago, Ill. All entries must be postmarked not later than midnight, August 31, 1947, to be eligible.

FOREIGN • • • • • •

International Fuel Economy Conference. The World Power Conference has announced an international fuel economy conference to be held September 2–9, 1947, at The Hague, Netherlands. Subjects for discussion will be the production, distribution, and utilization of fuels of all types, with special reference to wartime experiences and to developments realized since 1939 or now in prospect. Details of the program will be available in the near future. During recent months reports on "Fuel Economy Since 1939" have been issued by the national committees of eight countries. These reports picture the wartime fuel situation in considerable detail. Inquiries concerning these or other publications of the World Power Conference may be addressed to H. C. Forbes, Treasurer and Secretary, Executive Committee of the United States National Committee, World Power Conference, 4 Irving Place, New York 3, N. Y.

Belgium—Industrial Control Exhibit. An Exhibition of Industrial Control is to be held August 2 to September 28, 1947, at Liége, Belgium. Inquiries may be addressed to J. Leonard, Association des Ingenieurs, 31 Rue Saint-Gilles, Liége, Belgium.

Peru—Electronics Exposition. The first Radio-Electronics Exposition is to be held at Lima, Peru, July 28 to August 17, 1947. Inquiries should be addressed to Ingeniero Jorge Vargas Escalante, Director Gerente, Primera Exposicion de Radio-Electronica, Casilla 538, Lima, Peru.

Great Britain—Engineering and Marine Exposition. An Engineering and Marine Exhibition is to be held in London, August 28 to September 13, 1947. Inquiries should be addressed to F. W. Bridges and Sons Ltd., Grand Buildings, Trafalgar Square, London, W. C. 2, England.

OTHER SOCIETIES •

IME 100 Years Old. The Institution of Mechanical Engineers, London, England, marked its 100th anniversary in July. It was organized in 1847 under the presidency of the pioneer locomotive engineer, George Stephenson. The institution has encouraged advancement of engineering science, and has promoted research in mechanical engineering by providing grants and organizing research committees. It has served as a model for many engineering organizations including the American Society of Mechanical Engineers. Alfred Iddles, vice-president and director of the Babcock and Wilcox Company of New York, and past vice-president of the American Society of Mechanical Engineers; and Doctor A. G. Christie, professor of mechanical engineering, Johns Hopkins University, Baltimore, Md.; are the two official delegates representing the American Society of Mechanical Engineers at the centenary celebration of the British society.

IRE Chicago Section Holds Meeting. The Chicago Section of the Institute of Radio Engineers, at its final 1947 spring meeting, elected the following officers for the coming year: *chairman*, Karl Kramer, Jensen Manufacturing Company; *vice chairman*, Kenneth Jarvis (M '34) consulting engineer; and *secretary-treasurer*, Don Haines, Hytron Radio Corporation. The technical program prior to the business meeting featured a paper by W. E. Bloecker of the American Telephone and Telegraph Company titled "Interconnecting Facilities for Television Broadcasting." Both long haul and short haul circuits were discussed.

Hudson Division ARRL Convention. Asbury Park, N. J., is to be the site of the Hudson Division ARRL Convention on September 26–28, 1947. The convention is being sponsored by the Jersey Shore Amateur Radio Association and Monmouth County Amateur Radio Association. An extensive program has been planned including several technical talks, a visit to the moon radar set at its site in nearby Belmar, N. J., and talks on new amateur radio techniques and equipment. It is expected that amateur station *K2USA* will be on the air at the convention hall. Tickets are $3.50 each for the three day convention, and $4.00 for the banquet (limited to first 500 on advance reservation). Tickets may be obtained from M. Krause, Jr., (*W2HKY*), 135 Bridge Street, Red Bank, N. J.

FM Tested at Canadian Convention. The first large scale test of frequency modulation in Canada was held at Jasper National Park as a feature of the annual convention of the Canadian Association of Broadcasters at Jasper Park Lodge. The

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Future Meetings of Other Societies

American Chemical Society. 112th national meeting, September 15–19, 1947, New York, N. Y.

American Institute of Chemical Engineers. Annual meeting, November 9–12, 1947, Detroit, Mich.

American Institute of Mining and Metallurgical Engineers. Regional meeting, September 29–October 1, 1947, Denver, Colo.

American Society of Civil Engineers. Fall meeting. October 15–18, 1947, Jacksonville, Fla.

American Society of Mechanical Engineers. Fall meeting, September 1–4, 1947, Salt Lake City, Utah.

American Society of Tool Engineers. 16th annual meeting and tool exhibition, March 15–19, 1948, Cleveland, Ohio.

American Standards Association. Annual meeting, October 21–23, 1947, New York, N. Y.

American Transit Association. Annual convention, October 8–10, 1947, Atlantic City, N. J.

American Welding Society. Annual meeting, October 20–24, 1947, Chicago, Ill.

Association des Ingénieurs. Centenary congress and exhibition, August 30–September 13, 1947, Liége, Belgium.

Association of Iron and Steel Engineers. Annual meeting, September 22–25, 1947, Pittsburgh, Pa.

Canadian Institute of Radio Engineers. Convention, April 30–May 1, 1948, Toronto, Ontario, Canada.

CIGRE (International Conference on Large Electric High-Tension Systems). Biennial meeting, June 24–July 3, 1948, Paris, France.

Conference on Electrical Insulation. Meeting, September 24–7, 1947, at the Massachusetts Institute of Technology, Cambridge, Mass.

Exposition of Chemical Industries. 21st annual exposition, December 1–5, 1947, New York, N. Y.

Illuminating Engineering Society. Annual convention, September 15–19, 1947, New Orleans, La.

Institute of the Aeronautical Sciences. Annual meeting, August 7–8, 1947, Los Angeles, Calif.

Institute of Radio Engineers. West coast IRE convention, September 24–6, 1947, San Francisco, Calif.

Instrument Society of America. Second national conference, September 8–12, 1947, Chicago, Ill.

International Lighting Exposition and Conference. November 3–7, 1947, Chicago, Ill. Sponsored by National Electrical Manufacturers Association.

International Municipal Signal Association, Inc. 52d annual meeting, September 29–October 2, 1947, Grand Rapids, Mich.

National Association of Manufacturers. 52d Annual Congress of American Industry, December 3–5, 1947, New York, N. Y.

National Electrical Contractors' Association. 46th annual meeting, September 8–10, 1947, San Francisco, Calif.

National Electrical Manufacturers Association. October 27–31, 1947, Atlantic City, N. J.; winter convention, March 14–18, 1948, Chicago, Ill.

National Electronics Conference. November 3–5, 1947, Chicago, Ill.

National Machine Tool Builders' Exhibit. September 17–26, 1947, Chicago, Ill.

National Safety Congress and Exposition. 35th annual meeting, October 6–10, 1947, Chicago, Ill.

Pacific Chemical Exposition and Pacific Industrial Conferences. October 21–28, 1947, San Francisco, Calif.

Refrigeration Equipment Manufacturers Association. All-Industry Refrigerating and Air-Conditioning Exposition. January 26–29, 1948, Cleveland, Ohio.

members all seemed impressed with frequency modulation as a new medium of broadcasting and probably have learned a great deal from the week's experiment. Various companies interested in the manufacture of radio equipment co-operated in putting on the test with staffs from Calgary and Edmonton.

RMA Expands Industry Services at 23d Annual Convention

Expanded industry services to help radio manufacturers readjust their operations to postwar conditions were authorized by the new RMA board of directors today at the concluding business session of the 23d annual Radio Manufacturers Association convention held in Chicago, Ill., June 10–12, 1947. Among the new services authorized was the expansion and modernization of statistical services to cover the movement of radio and television receivers to distribution channels and their retail sales. A special committee was appointed to set up the machinery by which a monthly panel survey of the movement of sale of radio sets can be made. This committee also was authorized to work out improvements in the reports on radio set production.

Max F. Balcom, vice-president and treasurer of Sylvania Electric Products Inc., Emporium, Pa., was elected president of the association; R. E. Carlson, vice-president of Tung-Sol Lamp Works, Newark, N. J., and W. J. Barkley, executive vice-president of the Collins Radio Company, Cedar Rapids, Iowa, were elected vice-presidents; Leslie Muter of the Muter Company, Chicago, Ill., was re-elected treasurer; and Doctor W. R. G. Baker, vice-president of General Electric Company, Syracuse, N. Y., was reappointed director of the RMA engineering department.

The three day convention was concluded with a banquet attended by nearly 800 industry leaders and their guests. David Sarnoff, president of the Radio Corporation of America, predicted tremendous developments in radio, television, and electronics in an address titled "The Outlook for the Radio Industry".

Membership in the association reached its highest peak of 347 members at the 23d convention with the admission of 12 new member companies.

Corrosion Committee Holds Ninth Annual Meeting

The American Co-ordinating Committee on Corrosion held its ninth annual meeting in Chicago, Ill., April 8, 1947. The objectives of this organization are

1. The collection of information regarding research programs in the field of corrosion.

2. The dissemination of this information through a directory or in answer to individual inquiries.

3. The conduct of surveys on the status of corrosion research in various fields, to recommend to interested societies or to the scientific profession the desirability of further studies in any particular field.

4. Co-operation with other organizations in the United States and in foreign countries as the means for interchanging information on corrosion.

One of the most important single contributions which the committee has made is the circularization of American technologists to determine the real extent of full-time interest in corrosion problems. It made available a check list of engineers and technologists in specialized fields of corrosion work in a directory which lists more than 500 individuals.

A glossary of standard terms and symbols has been prepared in co-operation with the electrochemical society and will appear in the Corrosion Handbook soon to be published under the auspices of the Electrochemical Society's corrosion division.

The AIEE is taking an active part in the work of the committee, being represented by H. S. Phelps (M '45) and J. M. Standring, Jr., (A '40). About 23 technical and research organizations are represented on the committee.

ASQC Holds First Annual Convention. The American Society for Quality Control held its first annual convention in Chicago, Ill., June 5–6, 1947, in conjunction with the second Midwest Quality Control Conference. In some 35 clinical sessions, stories of the application of quality control principles to fields ranging from inventory control to ammunition were presented. About 30 exhibitors demonstrated the value of their equipment as aids to the quality control operator. The officers of this organization include: *president*, George D. Edward, director of quality assurance, Bell Telephone Laboratories, New York, N. Y.; *vice-president*, Andrew I. Peterson, manager, quality control department, Radio Corporation of America, RCA Victor Division, Camden, N. J.; *executive secretary*, Ralph E. Wareham, National Photocolor Corporation; and *treasurer*, Alfred L. Davis, Rochester Institute of Technology, Rochester, N. Y. Several talks on the relationship between management and quality control also were delivered.

JOINT ACTIVITIES

Report Nearing Completion on Engineering Profession Survey

The Engineers Joint Council has authorized publication of the report on the survey of the engineering profession, upon advice of Colonel William N. Carey, executive secretary, American Society of Civil Engineers, chairman of the Engineers Joint Council committee on the survey of the engineering profession, that the manuscript practically is completed.

Committee work on the survey first was started in 1945. Last August, copies of the precoded questionnaire (*EE, Aug-Sept '46, p 425*) were mailed to an unduplicated mailing list of the United States resident members of the six national engineering societies participating in the survey—American Institute of Chemical Engineers, AIEE, American Institute of Mining and Metallurgical Engineers, American Society of Civil Engineers, and American Society of Mechanical Engineers, which make up the council; and the National Society of Professional Engineers, participating in this project by invitation of the council. Co-operation by the Bureau of Labor Statistics, United States Department of Labor, was obtained for utilization of the department's mechanical tabulation equipment. The tabulations furnish the statistical basis for the report, which its author, Andrew Fraser, the committee's consultant, has titled, "The Engineering Profession in Transition."

Principle objectives of the questionnaire were

1. To determine the general impact of World War II on the engineering profession in the period 1939 through 1946.

2. To obtain reliable data from which valid findings could be derived to predict the activity pattern of the profession subsequent to the year 1946.

3. To determine if the war's upheaval had changed materially the pattern of professional activities, educational background, and earnings from those which existed in the years prior to 1939.

The report is a statistical analysis of economic factors as they are shown to affect the individual professional engineers who answered the questionnaire. Basic factors analyzed are age, sex, year of entering profession, educational level, and veteran's status. Also covered are factors affecting engineer employment and earning capacity, among which are geographical location, general field of employment, industrial field, and occupational status. Comparisons cover three significant years, before, during, and after World War II—the years 1939, 1943, and 1946.

Because the survey questionnaire was confined to members of the six principal national professional engineering societies, the committee believed that for the first time there has been produced a survey which directly covers the engineering profession in the United States, and which is restricted solely to persons known to be qualified members of that profession.

RESEARCH • • • • •

Industrial Research Institute Holds Annual Meeting

The Industrial Research Institute, a nonprofit organization for the promotion of improved management in industrial research, held its ninth annual meeting on June 5–6, 1947, in Swampscott, Mass. N. A. Shepard, chemical director of American Cyanamid Company, was elected president, and E. W. Engstrom, vice-president in charge of research of the RCA Laboratories, vice-president for the ensuing year.

Doctor Charles Allen Thomas, executive vice-president, Monsanto Chemical Company, was presented the Industrial Research Institute Medal for his pioneering and inspiring leadership in the development of the American industrial research system. Doctor Karl T. Compton, president, Massachusetts Institute of Technology, Cambridge, addressed the Institute on the subject of tilling the soil for the industrial research crop. Among the other features of the meeting were two panel discussions. One, on the subject of what has been done or what might be done to develop better methods of selecting industrial research workers, was led by four industrial psychologists. The other panel, made up of management consultants, presented its views on such topics as the function and place of research in an industrial organization, effective management techniques, and the trend toward increasing responsibility for the research executive in shaping company management policy. An inspection tour of the research laboratories of Massachusetts Institute of Technology was included on the program.

Program Proposed for Fuel Economy Research

A proposed long-range program of co-operative research in engineering between the petroleum and automotive industries which would lead to greater fuel economy in motor vehicle operation was outlined by C. F. Kettering (F '14), General Motors' vice-president in charge of research, at the summer meeting of the Society of Automotive Engineers, held at French Lick, Ind., June 1–6, 1947. Mr. Kettering said that high compression engines giving from 33 to 40 per cent higher economy than today's automobile engines have been running cars in the Detroit and Dayton areas since last November. His paper, "More Efficient Utilization of Fuel," is a progress report on work carried on by the General Motors Research Laboratories over a generation on engine and gasoline research in which a series of experiments point the way for future improvements in the automobile through co-operation between the petroleum and automobile industries.

He described experiments on a single cylinder engine using as high as a 15-to-1 compression ratio. Experiments on a 6-cylinder car engine of 12.5 to 1 followed the elementary single cylinder test. These pressures are reached today only in Diesel engines. Drawing from Diesel design and a large amount of mechanical design in many fields, an engine was built which gave smooth operation in an automobile chassis.

These engines and fuel development are in the laboratory stage and how soon they can be incorporated in an automobile will depend upon a large amount of development by both the automobile and petroleum industries working toward a common goal.

HONORS • • • • • •

New York Utility Wins Charles A. Coffin Award

The annual Charles A. Coffin Award by the General Electric Company to a public utility for outstanding public service and benefit to American industry was presented to the New York State Electric and Gas Corporation at the annual meeting of the Edison Electric Institute, at Atlantic City, N. J., June 4, 1947. The award comprises a gold medal and $1,000 presented to the recipient employees benefit or similar fund.

The 1947 winner received the award for the development of the Jennison steam station, using fuel which heretofore had been considered of little value, to give a low-cost production of electricity, and for excellent progress in rural electrification. Presentation of the award to public utilities was suspended during the war with the exception that in 1944 the entire electric light and power industry was cited in recognition of the general excellence of the industry's contribution to the war effort.

Students Win NEMA Electric Arc Welding Prizes. Ronald Wishart, Jr., a chemical engineering senior at Rensselaer Polytechnic Institute, Troy, N. Y., won the $500 National Electrical Manufacturers Association's Electric Arc Welding prize for the best history of the electric arc welding industry entitled "The Arc Triumphs." According to the rules of the contest only one prize of $500 was to have been given. However, another manuscript, submitted by Henry Wilenius of Wayne University, Detroit, Mich., who is majoring in mechanical engineering, merited a special award of $200 in the opinion of the judges.

Colorado Line Crew Wins Claude L. Matthews Valor Award

A 12-man line crew of the Public Service Company of Colorado has been awarded the 1946 Claude L. Matthews Valor Award, which was established to honor acts of devotion to duty wherein extraordinary courage has been exercised in efforts to maintain important electric service or to restore service in the shortest possible time. The men are E. V. Stuart, line superintendent; Eldin G. Larsen, assistant line superintendent; Glen C. Farnsworth; Sam. C. Phillips; A. J. Lundsden; E. D. O'Connor; Ernie Richey; E. L. Noland; G. E. Atkinson; T. G. Johnson; Harry O. McIntosh; and S. M. Stroebeck.

During a 13-day blizzard in January 1946, this group of men averted imminent destruction of an isolated section of one of the company's major 110,000-volt transmission circuits, thereby saving property and preserving service to an important area of the population. The award was presented at the annual meeting of the Edison Electric Institute in Atlantic City, N. J., June 4, 1947.

Russian Engineer Honored by ASCE Section. Nikolai D. Bassov, Union of Socialist Soviet Republics member of the Board of Design of the United Nations permanent headquarters, was honored at a luncheon given by the Metropolitan section of the American Society of Civil Engineers at the University Club, New York, N. Y., June 12, 1947. About 40 leading engineers in the city attended. Mr. Bassov is the only engineer on the Board of Design, all the other representatives of the various nations being architects. Colonel Max Abramovitz, Deputy Director of the Board of Design and a member of the architectural firm of Harison and Abramovitz, paid tribute to the guest of honor and his professional attainments. Mr. Bassov responded in an informal address.

G. L. Beers Receives Honorary Degree. George L. Beers, assistant director of engineering of the RCA Victor Division, Radio Corporation of America, received the honorary degree of doctor of science from Gettysburg College, Gettysburg, Pa., at the institution's 115th commencement exercises. Mr. Beers has been associated with the company for nearly 26 years. He is well known in radio circles as a frequent contributor to technical periodicals and books.

AWS Undergraduate Award Winners Announced

John W. Price, Jr., of Rose Polytechnic Institute, Terre Haute, Ind., and Howard Sanders, of Cornell University, Ithaca, N. Y., have been selected as winners of the $200 first prize and $150 second prize, respectively, in the 1947 A. F. Davis Undergraduate Welding Award. Sponsored by A. F. Davis, vice-president and secretary of the Lincoln Electric Company, the award is an annual event of the American Welding Society.

"Atomic-Hydrogen Arc Welding" was the subject of Mr. Price's paper, published in the March 1947 issue of the *Rose Technic*. Mr. Sanders' article, "Welders in Diving Suits," appeared in the March 1947 issue of the *Cornell Engineer*. Each of these undergraduate magazines also will receive awards of $200 and $150 respectively for being the publications in which the prize winning articles were printed. Although the subject matter may be on any phase or any type of welding or its application to design and construction, the articles must be published during the preceding year in an undergraduate magazine or paper to be considered for the prizes.

LETTERS TO THE EDITOR

INSTITUTE members and subscribers are invited to contribute to these columns expressions of opinion dealing with published articles, technical papers or other subjects of general professional interest. While endeavoring to publish as many letters as possible, Electrical Engineering reserves the right to publish them in whole or in part or to reject them entirely. Statements in letters are expressly understood to be made by the writers. Publication here in no wise constitutes endorsement or recognition by the AIEE. All letters submitted for publication should be typewritten, double-spaced, not carbon copies. Any illustrations should be submitted in duplicate, one copy an inked drawing without lettering, the other lettered. Captions should be supplied for all illustrations.

Status of the Engineer

To the Editor:

While we were in Indianapolis last summer there was considerable commotion about the status of the engineer. A number of articles and discussions have been printed in various magazines before and since that time. The other day it occurred to me that the engineer is just beating around the bush in trying to improve his status.

The past several years have brought considerable discussion in engineering circles concerning the status of the so-called professional engineer. First, there is some question as to what a professional engineer might be. The definition of a professional engineer, or what he might be, to this extent is beside the point, since much of the discussion has concerned itself about why an engineer should or should not be subjected to joining a labor organization, or perhaps better, why the Wagner Labor Act should have anything to do about an engineer's status.

An engineer always has been understood to be one who tries to determine why certain problems occur . . . and he applies all of his energy and talent to find a solution . . . There is some question as to whether or not engineers have applied this principle in determining how to solve the present status of an engineer in the engineering profession. Reference seems always to be made to the legal profession or to the medical profession. This may or may not be good reference. If reference is made to such organizations, perhaps the engineer should analyze the status of operation of such organizations and apply it to his own field.

Most everyone knows that any manufacturing concern, any power company, telephone company, or other public utility credits its standing, its service, and its success to the talent, ingenuity, foresight, and economical operation of its engineers. The engineering organization is the one outstanding group of any such company that makes the profits and sees that the services are not only continuous but the best that engineering talent can provide.

In looking over the entire picture, it seems that the engineers' problem is in the hands of the engineers. Any legal action, any registration, or other operations of that kind are just jumping over the real problem and trying to dodge the entire question concerning the status of the engineer. The Wagner Act so far has not applied to men who receive a salary above a certain limit. It therefore is logical to assume that if engineers are paid a small amount more, the Wagner Act would not apply. That difference in pay automatically would put the engineer in a class of his own and therefore no legal action would be required to keep him out of the jurisdiction of the Wagner Act.

In looking over the status of engineers in all large companies, it seems that the man who does engineering work does not have a salary comparable to that of men of other professions in the same company. This statement does not apply to those men who are graduate engineers but are now in executive positions and therefore do not work as actual engineers in the so-called engineering field. In most such companies, the pay of the highest rated engineer that does engineering work may range between $10,000–$15,000 a year while at the same time the highest paid legal talent in the same company will be paid at least twice such figures. This difference is the engineer's fault.

The engineer has been so trained and has operated many years so as to get the best job done at the least cost. Apparently he has applied these same tactics to himself. If there was ever a profession that undersold itself, it is the engineering profession. Many of these high ranking engineers justly decided that $10,000–$15,000 a year is a sufficient salary for the work they do. That is readily agreed from a standpoint of an engineer's way of doing a job. From the professional engineer's point of view, this is very shortsighted. This engineer apparently does not realize that when he limits his salary to $15,000 a year when he could actually get $30,000 a year for the same work, he just about has cut the salary of every engineer under him 50 per cent. Our system is such that salaries are graded down from the top man. That is a good system, but when the top man does not take or insist on getting the highest salary the job can carry, he is a detriment to every engineer in the engineering profession.

We as engineers are willing to take young graduates from college, put them to work, and pay them measly salaries that are not even as much or not any more than those of ordinary laborers. Not only that, after laborers have done such ordinary work for a period of a few months their pay is increased and, as soon as they reach a proficiency of a rating that is termed skilled labor, their pay is considerably higher than that which most companies see fit to pay graduate engineers.

Engineers do not need to organize; they need not necessarily become registered engineers, but the top engineers must get together, look at the problem from an engineering standpoint, and determine the cause of the present status of the professional engineer. Once that cause is determined, and engineers certainly can determine it, no engineer will have any problem in correcting the difficulty, and engineers in the future need not worry about their standing in the community in which they live or their standing beside the other so-called professional groups. The whole problem is in our hands and we need not go to state legislatures, registration groups, or to the National Government for any help at all. Our top engineers, with a little consideration of what they went through to get to the top and the conclusion not to undersell the engineer, readily can solve the problem. It seems regrettable, in looking over the things engineers have done, that the picture sums up in this way. The engineer controls the operation and destiny of the whole country in time of peace as well as in time of war, yet has practically no control, or at least has not applied any control to his own destiny.

A. W. RAUTH (M '41)

(Secretary-treasurer, Michigan Section; Consumers Power Company, Jackson, Mich.)

Flux Linkage

To the Editor:

The principle of constant flux linkages is well explained in Johnson's "Mathematical and Physical Principles of Engineering Analysis." Briefly stated, along with its analogies taken from mechanics, we have

LI (before) $= LI$ (after)
constant flux linkage

MV (before) $= MV$ (after)
translational collision

$J\omega$ (before) $= J\omega$ (after)
rotational collision

The last two generally will be identified as the constant momentum law. To this I would like to add a fourth principle from electrostatics, that is,

CE (before) $= CE$ (after)

or

Q (before) $= Q$ (after)

The principle of duality may provide persuasion if not logic for this development, thus,

$$\begin{tikzcd} L \arrow[d] & I=LI \arrow[d] \\ \text{Dual} \arrow[d] & \text{Dual} \arrow[d] \\ C & E=CE \end{tikzcd}$$

The principle may be tested by a few examples.

Suppose a 20-microfarad capacitor to be charged to 110 volts and then connected to a 10-microfarad capacitor. What will be the final voltage and energy before, after, and lost at the switch? This problem may be paraphrased easily, thus: suppose a 20-pound weight to be moving at 110 feet per second and then to collide with a 10-pound weight. What will be the final velocity and energy before, after, and lost in heat, assuming no rebound?

$$Q \text{ (before)} = 20 \times 110 \text{ microcoulombs} = 2{,}200$$

$$Q \text{ (after)} = 20E + 10E = 2{,}200$$

$$E = 73.3$$

$$\text{Energy before} = \frac{1}{2} \times 20 \times (110)^2 = 121{,}000 \times 10^{-6}$$

$$\text{Energy after} = \frac{1}{2} \times 20 \times (73.3)^2 + \frac{1}{2} \times 10 \times (73.3)^2 = 80{,}550 \times 10^{-6}$$

$$\text{Energy lost} = 40{,}450 \times 10^{-6}$$

Similarly with the momentum problem

$$MV \text{ (before)} = 20 \times 110$$

$$MV \text{ (after)} = (20+10)V$$

$$V = 73\tfrac{1}{3} \text{ feet per second}$$

Similarly a trace of the energies may be made.

Suppose a 20-microfarad capacitor to be charged to 220 volts and a 10-microfarad capacitor to be charged to 110 volts and then the two are connected in series opposition and conjunction. To what voltages will the capacitors settle down?

Plus terminals connected together,

$$Q \text{ (before)} = 20 \times 220 + 10 \times 110 = 5{,}500 \text{ microcoulombs}$$

$$Q \text{ (after)} = 5500 = 20E + 10E$$

$$E = 183.3$$

Plus terminals connected to minus terminals,

$$Q \text{ (before)} = 20 \times 220 - 10 \times 110 = 3{,}300 \text{ microcoulombs}$$

$$Q \text{ (after)} = 3{,}300 = 20E + 10E$$

$$E = 110$$

An energy balance may be made here, just as in the first example.

L. A. DOGGETT (F '36)

(Professor of electrical engineering, The Pennsylvania State College, State College)

Reorientation in Engineering Curricula

To the Editor:

In a recent issue (*EE, Feb '47, pp 212–13*) a letter to the editor appeared by M. M. Samuels on the need of reorientation in the engineering curricula. The letter gave a brief but excellent analysis of the various schools of thought on engineering education, classifying them as universalist, specialist, and fundamentalist. It is interesting to note that these classifications are not necessarily incompatible. The universalist, who believes in an extremely broad general educational background, probably would not object to specialization in addition to this general education. The specialist, who advocates a narrow expertness in a single field, would not be likely to disapprove of the additional presence of some general education. Neither would the fundamentalist object to specialization—provided, of course, the fundamental principles were fulfilled first.

A logical compromise would be a combination of all three of these—and that is what the engineering schools have tried to do. The modern electrical engineering curricula consists of the fundamental courses of physics, chemistry, mechanics, and mathematics. The general educational subjects, or humanistic subjects, are psychology, history, English, and economics. The specialization is found in electrical machinery and electronics.

This basic curricula, which, in one form or another, is almost standard in all electrical engineering schools, has been severely attacked and defended ever since formal electrical engineering education made its debut in our universities some 50 years ago.

The attacks have been on precisely the same bases that Mr. Samuels describes. The curricula is either not broad enough in general education (universalist), or it is too broad (specialist), or it is not fundamental enough (fundamentalist). Quite naturally, the engineering schools, therefore, have clung to the middle of the road and compromised.

If the colleges had attempted to satisfy each viewpoint thoroughly, they would have had to institute a six to eight year program, similar to that given to law and medical students. Neither industry, students, nor faculties yet have shown their willingness to accept such a rigorous training. However, if we are going to adhere to the present four year curriculum, we must make a compromise. Engineering curricula almost without exception already are crowded to capacity. Any further increase in subject matter necessarily must result in a decrease in the efficiency and morale of the students.

Where then shall we limit our curricula? The fundamentalist will say, discard everything except the basic sciences. The specialist will maintain that thorough training in a narrow field is sufficient to make him an engineer. The universalist will argue for restriction to solely humanistic subjects. However, any of these will give a "narrow" training. The engineering student must know his fundamentals, but he also must have a general cultural education, and he must be sufficiently acquainted with the field he is about to enter to understand its peculiarities.

The fundamentals are basic to the engineering profession. All work that the student ever will develop will be based on these fundamentals. An engineer deficient in knowledge of fundamentals will find it extremely difficult to adjust himself to a new field of work. However, a few technically specialized subjects also are needed, for there the students learn to apply the fundamentals. The engineering profession is necessarily one of specialization. Why not train students how to cope with special problems as they will arise in industry? The fundamentals cannot do that by themselves. Mere possession of a tool is not enough—the student also must know how to apply it, its usefulness, and its limitations.

General education is necessary to prepare the students to take their place as responsible citizens in their community. Possibly, though this is not to be construed as an excuse, if the high schools were more thorough in this phase of education, it would ease the responsibility of our colleges and universities.

There is no necessity to discuss the details of this subject. The basic fact, however, is that the engineering curricula cannot be limited to a single point of view. Unquestionably, there is much opportunity for improvement, and the articles published each month in the *Journal of Engineering Education* and other magazines show that the universities and industry are not oblivious to this fact. Educational institutions are always somewhat conservative; however, when one considers the almost overburdening responsibility they carry in preparing youth as engineers and citizens, a little conservatism is an asset rather than a disadvantage.

H. W. FRIEDMANN

(Columbia University, New York, N. Y.)

To the Editor:

I would like to record a word of hearty approval of the ideas expressed in Professor Ryder's recent article (*EE, June '47, pp 535–7*).

It seems to me that the expansion of the college time of engineers in general to include more cultural and general education subjects is one of the outstanding problems in engineering education today. Professor Ryder's approach to this is an extremely sound one. If I were to make any comment at all about the suggestion, it would be that the curriculum might be extended to six years instead of five with profit. On the whole, however, the proposed plan is a progressive one, in contrast to the "do-nothing" attitude of some engineering schools in the face of mounting evidence that engineers tend to be too specialized and narrow. It is the exact antithesis of the article by Dean Langsdorf (F '12), which appeared about a year ago, and concerning which I expressed the following sentiments.

Professor Langsdorf's address (*EE, June '46, pp 251–4*), set forth, it seemed to me, a dangerous thesis for the profession to espouse. At the same time that the Institute and other major engineering societies are concerned with plans for consolidating, or at least re-emphasizing, the standing of the engineer in the community, there should be careful consideration given to means by which new members, entering the profession, may be more broadly equipped to merit that respect to which they aspire.

An engineering degree alone only assures the holder that he has learned the technical essentials of his profession. The holder may be the narrowest sort of drudge, with that lack of background and broad knowledge of human history, behavior, and thought which is at the root of the present low estate to which the profession has declined. Such an individual scarcely can be called a professional man. He has a certificate which indicates that he has completed an initial apprenticeship in his craft. And he is thus fair game for regimentation, unionization, and all the other activities which grow among those of limited scope, background, and vision.

The engineering profession needs more men who enter their professional training with sufficient maturity to appreciate their opportunities to benefit mankind and their responsibilities as citizens in the world. Adult education after leaving engineering school or during summer vacations will not provide this. Such instruction will be considered only as something to be endured, and will evoke little of the interest and inspiration which real teaching of cultural subjects should bring out.

A number of engineering schools already have required a college degree for admission. This means six or seven years from high school graduation before the embryo engineer starts to work at his profession. And there is time, in such a curriculum, to turn out a really well-educated engineer and citizen. Other professions do it. Why are engineering educators so afraid of lengthening the course of study? They certainly should be under no compulsion to turn out large quantities of engineers for industry on a mass-production basis. Industry would be better served by fewer, more mature, engineers who also are prepared by background and broad training to assume their rightful place in the community and in an honored and honorable profession.

EDWIN FLEISCHMANN (M '29)

(Consulting engineer, Palo Alto, Calif.)

NEW BOOKS • • •

The following new books are among those recently received at the Engineering Societies Library. Unless otherwise specified, books listed have been presented by the publishers. The Institute assumes no responsibility for statements made in the following summaries, information for which is taken from the prefaces of the books in question.

ANTENNAE, AN INTRODUCTION TO THEIR THEORY. By J. Aharoni. Clarendon Press, Oxford, England; Oxford University Press, New York, N. Y., 1946. 265 pages, diagrams, charts, tables, $9^1/_2$ by 6 inches, cloth, $8.50. The object of an antenna theory is for the determination of the type of antenna required to produce a specified field distribution. This book gives a comprehensive account of the mathematical developments in calculating these aspects of the properties of antennae. The three sections deal respectively with boundary-value problems, antennae and integral equations, and antennae as wave guides.

COURSE IN ELECTRICAL ENGINEERING, VOLUME 2. ALTERNATING CURRENTS. By C. L. Dawes. Fourth edition. McGraw-Hill Book Company, New York, N. Y., and London, England, 1947. 708 pages, illustrated, diagrams, charts, tables, $9^1/_4$ by 6 inches, cloth, $5. This standard text devotes the first two chapters to the development of the fundamental laws of alternating currents and a-c circuits. Subsequent chapters consider the application of these fundamental laws to measurements, to polyphase circuits, to machinery, and to power transmission. The last two chapters deal with electron tubes and rectifiers. Throughout the book the emphasis is on the fundamental phenomena. All material has been revised to cover the advances of the past 12 years, and some 500 new problems have been added.

DIFFRACTION OF X-RAYS AND ELECTRONS BY FREE MOLECULES. By M. H. Pirenne. University Press, Cambridge, England; Macmillan Company, New York, N. Y., 1946. 160 pages, illustrated, diagrams, tables, $8^3/_4$ by $5^1/_2$ inches, cloth, $3. This monograph is intended primarily to give an account of the theoretical basis of the study of X-ray diffraction by gases and of the information it has yielded about the structure of atoms and molecules. Consideration is also given to the diffraction of fast electrons by gases, the scattering of X rays by atoms in crystals, and the diffraction of X rays by liquids. A complete bibliography has been attempted of the original literature on X-ray diffraction by gases with some significant references on diffraction by liquids.

ELEMENTS OF RADIO. By C. I. Hellman. Second edition. D. Van Nostrand Company, New York, N. Y., 1946. 324 pages, illustrated, diagrams, charts, tables, $9^1/_4$ by 6 inches, cloth, $2.40. Provides for the beginner a thorough, understandable foundation in the principles of radio. The early chapters review in detail general electrical theory, alternating currents, and the properties of inductance, capacitance, and resonance. Electron tubes, oscillators, transmitters, receivers, antennae, and power supplies are described, with answers to specific questions. The last two chapters contain brief discussions of the cathode-ray oscilloscope and such electronic applications as frequency modulation, television, and radar.

ELECTRONIC CONTROL HANDBOOK. By R. R. Batcher and W. Moulic. Caldwell-Clements, Inc., New York, N. Y., 1946. 344 pages, illustrated, diagrams, charts, tables, 9 by $5^3/_4$ inches, leatherette, $4.50. The electrical and electronic principles employed in automatic control and regulation services are discussed in detail with emphasis on the versatility of electronic systems. Following the opening section, which gives the basic elements of control, separate sections are devoted to the three main parts of a control system: the conversion element (displacement, pressure, temperature, and so forth) which activates the electronic circuit; the electronic modification circuit itself (amplifiers, oscillators, bridges, and so forth); and the activation or correction element which produces the required change. The final section describes specific control applications.

ELECTRONICS FOR INDUSTRY. By W. I. Bendz with the assistance of C. A. Scarlott. John Wiley and Sons, New York, N. Y.; Chapman & Hall, London, England, 1947. 501 pages, illustrated, diagrams, charts, tables, $8^1/_2$ by 6 inches, cloth, $5. This book provides a practical, nonmathematical explanation of the fundamentals of electronics for engineers. It covers the types and functions of electronic tubes; the principles and operation of rectifiers, amplifiers, and oscillators; basic control circuits; and the application of high frequency for induction and dielectric heating. Emphasis is placed on the explanation of principles as applied to industrial equipment.

INDUSTRIAL HIGH VOLTAGE DISTRIBUTION AND PUBLIC SUPPLY. By E. J. Barrows. Sir Isaac Pitman and Sons, Ltd., London, England, 1946. 126 pages, diagrams, tables, $8^3/_4$ by $5^1/_2$ inches, cloth, 15*s*. The elements of electric transmission and distribution are presented for the works engineer who must establish an effective electric system for his plant. With a minimum of mathematics, examples are given of layouts showing transmission from power stations and the internal distribution in large industrial plants, as well as considerable detailed calculation concerning electric apparatus such as generators, switchgear, transformers, and cables. Operation principles are emphasized.

(THE) RADIO AMATEUR'S HANDBOOK, 24th edition, 1947. American Radio Relay League, West Hartford, Conn., 468 pages, illustrated, diagrams, charts, tables, $9^1/_2$ by $6^1/_2$ inches, paper, $1.25. The three main sections of this annual publication are as follows: "Principles and Design" covers comprehensively the theory of radio communications and design of amateur transmitting, receiving, radiating, and measuring apparatus; "Equipment Construction" starts with a brief chapter on workshop practice and continues with detailed instructions for the building of various types of equipment; "General" contains extensive tables of vacuum tube characteristics and miscellaneous data and a chapter on amateur radio operating. The whole volume has been revised thoroughly to conform with current practice. A catalog section of short wave equipment is appended.

RESISTANCE WELDING MANUAL (Revised Edition). Published by Resistance Welder Manufacturers' Association, Philadelphia, Pa., 1946. 544 pages, illustrated, diagrams, charts, tables, $9^1/_4$ by $5^3/_4$ inches, cloth, $3. The introductory section of this manual covers technical and economic fundamentals. Section II describes in detail the various resistance welding processes. The resistance welding characteristics of various important metal groups are considered separately in Section III, with information on how these characteristics affect welding procedures. Mechanical and electrical characteristics of welding machines are also covered in this section. Sections new in this revised edition deal with inspection, testing, and quality control, and with maintenance of equipment. Useful data tables and a glossary are appended.

PAMPHLETS • • •

The following recently issued pamphlets may be of interest to readers of "Electrical Engineering." All inquiries should be addressed to the issuers.

Standards for Dimensional Characteristics of Electron Tubes, Publication Number 502. A joint RMA–NEMA standard formulated by the Joint Electron Tube Engineering Council, $8^1/_2$ by 11 inches, 10 pages, 80 cents.

Standards for Gauges for Electron Tubes, Publication Number 503. A joint RMA–NEMA standard formulated by the Joint Electron Tube Engineering Council, $8^1/_2$ by 11 inches, 5 pages, 50 cents.

Basic Radio Propagation Predictions for August 1947, Three Months in Advance, CRPL-D33. A National Bureau of Standards publication. Superintendent of Documents, Government Printing Office, Washington 25, D. C., 15 cents.

Off-the-Job Accidents and You. A pocket-sized booklet for industrial and office workers which warns against off-the-job accidents. National Conservation Bureau, Accident Prevention Division of the Association of Casulty and Surety Companies, 60 John Street, New York 7, N. Y.

Depreciation Policy and the Post-War Price Level. Machinery and Allied Products Institute, 120 South La Salle Street, Chicago 3, Ill., 6 by 9 inches, 22 pages, 25 cents.

A Guide to the Literature on the History of Engineering. A classified bibliography of works available in the Cooper Union Library, compiled by that organization. Librarian, The Cooper Union Library, Cooper Square, New York, N. Y., 7 by 10 inches, 50 pages.